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Final Technical Report for NASA Grant NAG-2-401

June 1986 through September 1986

TWO-DIMENSIONAL AERODYNAMIC CHARACTERISTICS OF THE AMES HI-120, HI-8, AND LOW-12 AIRFOILS

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INTRODUCTION

During the period between June 1986 and September 1986, the Aeronautical and Astronautical Engineering Research Laboratory (AARL) at The Ohio State University (OSU) in Columbus, Ohio, conducted tests in the 6"X22" Transonic Blowdown Wind Tunnel to determine the two-dimensional lift, drag, and pitching moment coefficients for three airfoils designated AMES HI-120, AMES LOW-12, and AMES HI-8. These tests covered a Mach number range of 0.20 to 0.86, Reynolds numbers between $2X10^6$ and $6X10^6$, and angles of attack between 0^o and 13^o as directed by the NASA Project Engineer, Mr. Ray Hicks; each model was not run at every condition. This work was performed under NASA Grant NAG-2-401, Analysis of Two Advanced Transonic Airfoils.

MODEL DESCRIPTION

The models used in these tests were constructed of aluminum power in an epoxy matrix, molded into the airfoil configuration. These models were cast with the pressure taps and internal tubing in place so that there are no disruptions of the finished surface caused by seams for openings in the model. The models span the entire 6-inch width of the wind tunnel with smoothly rounded fillets between the perpendicular surfaces of the airfoil and the mounting blocks used to position the model inside the tunnel. This design was chosen to eliminate any steps, sharp edges, or corners which would disturb the smooth flow of air as it approaches the model. The surface of each model is finished with an enamel to produce as smooth a surface as possible.

The 50 pressure taps distributed along the upper and lower surfaces of the model in a chordwise direction are connected by tubing which passes through the mounting blocks to an externally mounted Scanivalve which operates through guillotine cut-off valves. This arrangement allows for pressure measurements to be taken when the tunnel conditions have reached a steady state.

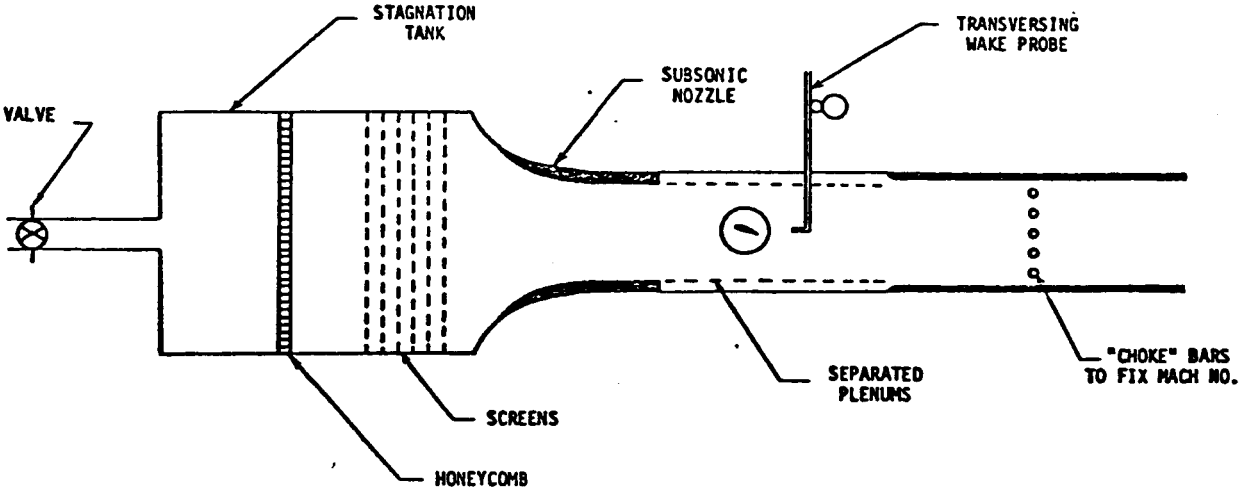
TUNNEL DESCRIPTION

Figure 1 shows a schematic representation of a blowdown wind tunnel. For a detailed description of the AARL wind tunnels and operating procedures, please refer to AIAA Paper No. 78-1118, "Testing Techniques and Interference Evaluation in the OSU Transonic Airfoil Facility", which is included with this report as Appendix A.

TEST RESULTS

Data from these tests are presented in Tables I, II, and III and summarized in plots, Figures 2 through 40. Copies of the pressure distributions for each run, together with a magnetic tape were forwarded to Mr. Hicks in September 1986.

THE OSU AIRFOIL TEST FACILITIES



Schematic of Two Dimensional Wind Tunnels

Features:

A low turbulence level facility with 6" x 22" test section

Near on-line data processing - hard copy printout and plots available immediately after test

A high Reynolds number facility with 6" x 12" test section

Airfoil models are low cost, molded aluminum-epoxy with graphite for strength; 4 inch to 6 inch chord with more than 50 pressure taps.

Models can be changed quickly between two facilities

Up to 40 test runs per day

FIGURE 1

TABLE I

RUN SUMMARY

AMES HI - E
IN 6 X 22 TUNNEL

RUN NUMBER	MACH NUMBER	REYNOLDS NUMBER	ALPHA	CL	CD WAKE	CM
2861	0.20	2.09	0.0	0.565	.0066	-.122
2862	0.20	2.16	4.0	0.516	.0118	-.113
2863	0.20	2.23	8.0	1.213	.0388	-.087
2864	0.21	2.29	10.0	1.217	.0764	-.067
2865	0.21	2.23	12.0	1.136	.1328	-.129
2866	0.21	2.39	11.0	1.238	.1043	-.081
2867	0.40	4.23	0.0	0.555	.0063	-.122
2868	0.41	4.48	4.0	0.528	.0109	-.112
2869	0.41	4.38	8.0	1.226	.0385	-.082
2870	0.41	4.32	10.0	1.215	.0810	-.078
2871	0.41	4.54	11.0	1.161	.1178	-.115
2872	0.60	6.06	5.0	1.145	.0165	-.111
2873	0.60	5.30	6.0	1.316	.0225	-.108
2874	0.60	5.45	6.0	1.316	.0224	-.106
2875	0.60	5.69	6.0	1.312	.0224	-.106
2876	0.60	5.26	7.0	1.375	.0314	-.095
2877	0.61	5.57	7.0	1.364	.0312	-.093
2878	0.61	6.00	8.0	1.319	.0500	-.085
2880	0.75	5.62	3.0	1.092	.0311	-.178
2881	0.75	5.57	3.5	1.046	.0436	-.158
2882	0.75	5.57	4.0	1.019	.0534	-.151
2883	0.80	5.48	3.5	0.923	.0557	-.174
2884	0.80	5.46	3.5	0.945	.0421	-.174
2885	0.80	5.51	4.0	0.946	.0708	-.175
2886	0.79	5.65	5.0	0.944	.0877	-.159
2976	0.70	5.18	5.0	1.137	.0545	-.136
2977	0.70	5.59	5.5	1.141	.0618	-.135
2978	0.70	5.68	6.0	1.152	.0757	-.140
2979	0.70	5.88	7.0	1.135	.0812	-.133
2980	0.70	5.68	4.0	1.183	.0351	-.146
2981	0.50	4.94	5.0	1.079	.0135	-.110
2982	0.50	5.21	6.0	1.166	.0181	-.103
2984	0.50	5.39	7.0	1.244	.0240	-.091
2985	0.50	5.12	8.0	1.289	.0370	-.079
2986	0.50	5.22	9.0	1.274	.0584	-.072
2987	0.50	5.43	10.0	1.241	.0812	-.075
2623	0.60	5.55	0.0	0.598	.0062	-.130
2625	0.60	6.04	1.0	0.718	.0067	-.130
2626	0.60	6.03	2.0	0.818	.0079	-.128
2627	0.60	5.96	3.0	0.927	.0086	-.124
2628	0.60	5.70	4.0	1.040	.0106	-.118
2631	0.70	5.71	2.0	0.948	.0119	-.142

RUN SUMMARY

AMES HI - E
IN 6 X 22 TUNNEL

RUN NUMBER	MACH NUMBER	REYNOLDS NUMBER	ALPHA	CL	CD WAKE	CM
2632	0.70	5.79	1.0	0.784	.0084	-.140
2634	0.70	5.82	3.0	1.069	.0209	-.144
2635	0.70	5.81	4.0	1.175	.0337	-.145
2636	0.70	5.86	0.0	0.630	.0070	-.140
2637	0.75	5.85	0.0	0.684	.0089	-.153
2640	0.75	5.77	1.0	0.878	.0104	-.165
2641	0.75	5.86	4.0	1.026	.0531	-.151
2642	0.77	5.42	3.0	0.991	.0384	-.178
2643	0.77	5.49	2.0	0.959	.0245	-.186
2644	0.77	5.66	1.0	0.879	.0130	-.186
2645	0.78	5.66	0.0	0.740	.0090	-.172
2646	0.78	5.71	-1.0	0.546	.0080	-.160
2647	0.80	5.64	-1.0	0.547	.0078	-.174
2648	0.80	5.43	0.0	0.663	.0162	-.171
2649	0.80	5.79	1.0	0.768	.0210	-.177
2650	0.80	5.87	2.0	0.843	.0317	-.176
2652	0.80	5.55	3.0	0.893	.0484	-.176
2653	0.82	5.47	2.0	0.791	.0356	-.178
2654	0.82	5.39	1.0	0.716	.0259	-.181
2655	0.82	5.41	0.0	0.611	.0191	-.178
2656	0.82	5.39	-1.0	0.478	.0144	-.174
2657	0.84	5.50	-1.0	0.430	.0183	-.173
2658	0.84	5.52	-2.0	0.327	.0149	-.171
2659	0.84	5.75	0.0	0.555	.0225	-.174
2660	0.83	5.62	1.0	0.642	.0277	-.176
2662	0.83	5.41	2.0	0.747	.0446	-.177
2663	0.83	5.73	3.0	0.815	.0527	-.175
2664	0.83	5.75	4.0	0.893	.0663	-.178
2665	0.85	5.69	4.0	0.876	.0614	-.189
2666	0.85	5.72	3.0	0.793	.0578	-.185
2667	0.85	5.70	2.0	0.711	.0391	-.183
2668	0.85	5.83	1.0	0.609	.0327	-.180
2669	0.85	5.89	0.0	0.492	.0270	-.174
2670	0.86	5.65	-1.0	0.364	.0216	-.168
2671	0.86	5.62	-2.0	0.235	.0223	-.177
2672	0.73	5.74	0.0	0.661	.0076	-.145
2673	0.73	5.58	1.0	0.806	.0093	-.149
2674	0.73	5.75	2.0	0.985	.0167	-.157
2675	0.73	5.67	3.0	1.081	.0255	-.159
2676	0.73	5.67	4.0	1.137	.0480	-.153
2678	0.50	4.76	4.0	0.990	.0110	-.115
2679	0.46	2.49	4.0	1.035	.0009	-.109
2680	0.50	5.01	4.0	0.992	.0109	-.116
2681	0.50	4.84	4.0	0.989	.0108	-.115
2682	0.50	5.31	0.0	0.584	.0065	-.126
2683	0.50	4.88	1.0	0.689	.0068	-.126
2684	0.50	5.41	1.0	0.686	.0065	-.125
2685	0.50	5.57	2.0	0.801	.0072	-.124
2686	0.50	5.32	3.0	0.881	.0086	-.121
2687	0.50	5.33	4.0	0.978	.0107	-.115

TABLE II

RUN SUMMARY

AMES LOW- 12
IN 6 X 22 TUNNEL

RUN NUMBER	MACH NUMBER	REYNOLDS NUMBER	ALPHA	CL	CD WAKE	CM
2753	0.60	6.03	0.0	0.264	.0062	-.062
2754	0.60	5.78	3.0	0.615	.0084	-.061
2756	0.60	5.00	4.0	0.737	.0104	-.055
2757	0.60	5.84	2.0	0.497	.0075	-.062
2758	0.60	5.65	1.0	0.389	.0069	-.061
2759	0.70	5.38	1.0	0.409	.0068	-.064
2760	0.70	5.66	2.0	0.545	.0088	-.063
2761	0.70	5.67	3.0	0.711	.0144	-.063
2762	0.70	5.69	4.0	0.870	.0248	-.063
2763	0.70	5.40	0.0	0.272	.0069	-.062
2764	0.73	5.33	0.0	0.271	.0073	-.062
2765	0.73	5.38	0.0	0.271	.0074	-.062
2766	0.73	5.61	1.0	0.417	.0071	-.065
2767	0.73	5.75	2.0	0.564	.0101	-.065
2768	0.73	5.76	3.0	0.749	.0177	-.069
2769	0.73	5.68	4.0	0.892	.0283	-.074
2770	0.75	5.88	4.0	0.892	.0291	-.087
2771	0.75	5.62	3.0	0.772	.0178	-.080
2772	0.75	5.72	2.0	0.605	.0116	-.070
2773	0.75	5.72	1.0	0.434	.0079	-.067
2774	0.75	5.51	0.0	0.271	.0074	-.061
2775	0.78	5.56	0.0	0.268	.0077	-.061
2776	0.78	5.66	-1.0	0.102	.0097	-.047
2777	0.78	5.66	1.0	0.466	.0085	-.072
2778	0.78	5.37	2.0	0.638	.0136	-.083
2780	0.78	5.51	2.0	0.634	.0134	-.082
2781	0.78	5.54	3.0	0.750	.0235	-.092
2782	0.78	5.64	4.0	0.805	.0362	-.087
2783	0.80	5.57	4.0	0.698	.0439	-.080
2784	0.80	5.62	3.0	0.653	.0321	-.086
2785	0.80	5.62	2.0	0.608	.0227	-.095
2786	0.80	5.65	1.0	0.483	.0116	-.085
2787	0.80	5.47	0.0	0.265	.0120	-.057
2788	0.80	5.55	-1.0	0.088	.0284	-.023
2789	0.82	5.60	-1.0	0.101	.0434	-.018
2790	0.83	5.41	0.0	0.235	.0337	-.034
2791	0.82	5.67	1.0	0.398	.0215	-.072
2792	0.82	5.52	2.0	0.510	.0288	-.086
2793	0.82	5.65	3.0	0.554	.0445	-.076
2794	0.84	5.59	3.0	0.501	.0534	-.065
2795	0.84	5.47	4.0	0.540	.0530	-.058
2796	0.84	5.23	2.0	0.445	.0359	-.069
2798	0.84	5.08	2.0	0.429	.0342	-.060
2799	0.84	5.72	2.0	0.428	.0331	-.059

RUN SUMMARY

AMES LOW- 12
IN 6 X 22 TUNNEL

RUN NUMBER	MACH NUMBER	REYNOLDS NUMBER	ALPHA	CL	CD WAKE	CM
2800	0.84	5.67	1.0	0.313	.0370	-.038
2801	0.84	5.60	0.0	0.218	.0207	-.026
2802	0.84	5.69	-1.0	0.079	.0551	-.007
2803	0.84	5.73	-2.0	0.045	.0486	-.033
2804	0.86	5.77	-2.0	0.008	.0560	-.015
2805	0.86	5.71	-1.0	0.062	.0684	0.004
2806	0.86	5.94	0.0	0.135	.0566	0.008
2807	0.86	6.42	0.0	0.101	.0534	0.023
2808	0.86	5.67	0.0	0.135	.0393	0.006
2809	0.86	5.81	1.0	0.215	.0407	0.004
2810	0.86	5.72	2.0	.280	.0407	-.000
2811	0.80	3.30	3.0	0.650	.0353	-.085
2812	0.86	5.31	3.0	0.431	.0449	-.042
2813	0.86	5.68	3.0	0.408	.0578	-.030
2814	0.86	5.52	4.0	0.462	.0499	-.031

TABLE III

RUN SUMMARY

AMES HI-120
IN 6 X 22 TUNNEL

RUN NUMBER	MACH NUMBER	REYNOLDS NUMBER	ALPHA	CL	CD WAKE	CM
2453	0.60	5.60	0.0	0.613	.0069	-.131
2454	0.60	5.64	1.0	0.725	.0076	-.129
2455	0.60	5.87	2.0	0.817	.0099	-.125
2456	0.60	5.99	3.0	0.928	.0110	-.121
2457	0.60	5.43	4.0	1.016	.0130	-.114
2458	0.60	5.87	4.0	1.016	.0124	-.113
2460	0.70	5.44	4.0	0.997	.0483	-.139
2463	0.70	5.65	3.0	1.053	.0265	-.157
2464	0.70	5.53	2.0	0.952	.0173	-.153
2465	0.70	5.50	1.0	0.838	.0113	-.152
2466	0.70	5.84	0.0	0.669	.0073	-.144
2467	0.70	5.85	4.0	0.997	.0475	-.139
2468	0.75	5.74	4.0	0.819	.0696	-.133
2469	0.75	5.54	3.0	0.838	.0551	-.150
2470	0.75	5.62	2.0	0.866	.0436	-.174
2471	0.75	5.82	1.0	0.839	.0198	-.186
2472	0.75	5.75	0.0	0.701	.0135	-.169
2473	0.78	5.68	0.0	0.593	.0251	-.159
2474	0.78	5.56	-1.0	0.505	.0166	-.157
2476	0.77	5.45	1.0	0.675	.0399	-.161
2477	0.77	5.64	2.0	0.736	.0564	-.163
2478	0.77	5.45	3.0	0.804	.0717	-.166
2486	0.80	5.64	0.0	0.503	.0392	-.153
2487	0.80	5.60	-1.0	0.418	.0269	-.151
2488	0.80	5.54	1.0	0.578	.0521	-.153
2489	0.80	5.62	2.0	0.648	.0617	-.158
2490	0.82	5.48	2.0	0.615	.0652	-.163
2491	0.82	5.73	2.0	0.595	.0639	-.155
2492	0.82	5.50	1.0	0.525	.0554	-.153
2493	0.82	5.73	0.0	0.420	.0365	-.145
2494	0.82	5.59	-1.0	0.330	.0262	-.148
2495	0.85	5.76	-1.0	0.204	.0300	-.135
2496	0.84	5.62	-1.0	0.261	.0267	-.141
2497	0.83	5.61	0.0	0.408	.0360	-.156
2498	0.83	5.58	1.0	0.496	.0565	-.157
2500	0.86	4.95	-2.0	0.041	.0431	-.098
2501	0.86	5.49	-2.0	0.025	.0331	-.092
2502	0.86	5.42	-1.0	0.183	.0327	-.126
2503	0.86	5.69	-1.0	0.190	.0320	-.129
2504	0.86	5.54	0.0	0.322	.0376	-.144
2505	0.85	5.65	1.0	0.447	.0443	-.157
2506	0.85	5.59	2.0	0.539	.0701	-.155
2507	0.85	5.26	3.0	0.628	.0789	-.163
2508	0.85	5.45	3.0	0.624	.0801	-.162
2510	0.85	5.29	4.0	0.708	.0886	-.169

TABLE III pg 2

RUN SUMMARY

AMES HI-120
IN 6 X 22 TUNNEL

RUN NUMBER	MACH NUMBER	REYNOLDS NUMBER	ALPHA	CL	CD WAKE	CM
2511	0.83	5.61	2.0	0.577	.0446	-.157
2512	0.83	5.73	3.0	0.627	.0760	-.150
2513	0.83	5.36	4.0	0.714	.0904	-.162
2816	0.20	2.28	0.0	0.584	.0067	-.119
2817	0.20	1.90	2.0	0.743	.0102	-.114
2818	0.20	2.22	2.0	0.750	.0103	-.117
2819	0.20	2.17	4.0	0.925	.0142	-.109
2820	0.21	2.29	6.0	1.057	.0222	-.095
2821	0.20	2.02	8.0	1.164	.0374	-.083
2822	0.21	2.54	10.0	1.166	.0643	-.055
2823	0.21	2.28	11.0	1.218	.0854	-.058
2824	0.21	2.39	12.0	1.242	.1155	-.087
2825	0.21	2.38	13.0	1.197	.1502	-.070
2826	0.40	4.10	0.0	0.589	.0068	-.123
2828	0.41	4.50	2.0	0.757	.0087	-.118
2829	0.41	4.28	4.0	0.931	.0125	-.110
2830	0.41	4.36	6.0	1.096	.0202	-.101
2831	0.41	4.55	8.0	1.231	.0356	-.083
2832	0.41	4.34	10.0	1.240	.0642	-.063
2835	0.41	4.53	11.0	1.190	.0879	-.064
2836	0.60	6.48	5.0	1.122	.0162	-.108
2837	0.61	5.93	6.0	1.234	.0229	-.101
2838	0.61	5.71	7.0	1.396	.0299	-.108
2840	0.61	5.75	9.0	1.322	.0737	-.099
2841	0.61	5.72	8.0	1.450	.0429	-.092
2842	0.65	5.40	5.0	1.246	.0327	-.130
2843	0.65	5.34	5.0	1.232	.0324	-.129
2844	0.65	6.29	5.0	1.232	.0331	-.128
2845	0.64	5.71	0.0	0.639	.0071	-.137
2846	0.65	5.37	2.0	0.846	.0102	-.128
2847	0.65	4.92	4.0	1.125	.0181	-.131
2848	0.65	5.48	4.0	1.136	.0191	-.133
2849	0.65	6.03	6.0	1.241	.0497	-.116
2850	0.65	5.25	8.0	1.196	.0796	-.117
2851	0.65	5.90	7.0	1.195	.0627	-.115
2852	0.70	6.16	3.5	1.093	.0327	-.157
2853	0.70	6.01	4.0	1.015	.0461	-.140
2854	0.70	5.49	4.5	0.983	.0552	-.136
2855	0.70	5.98	3.0	1.054	.0264	-.158
2856	0.73	5.83	0.0	0.751	.0083	-.170
2857	0.73	5.16	2.0	0.967	.0257	-.175
2858	0.73	6.07	3.0	0.876	.0463	-.141
2859	0.73	5.85	2.5	0.920	.0361	-.155
2988	0.50	4.70	0.0	0.581	.0074	-.124
2989	0.50	5.15	4.0	0.971	.0130	-.111
2990	0.50	5.61	5.0	1.051	.0149	-.107

RUN SUMMARY

AMES HI-120
IN 6 X 22 TUNNEL

RUN NUMBER	MACH NUMBER	REYNOLDS NUMBER	ALPHA	CL	CD WAKE	CM
2991	0.50	5.66	6.0	1.139	.0182	-.101
2992	0.50	5.52	8.0	1.271	.0295	-.082
2993	0.50	5.21	9.0	1.313	.0415	-.069
2994	0.50	5.55	10.0	1.294	.0587	-.060
2995	0.50	5.50	3.0	0.890	.0105	-.117
2996	0.73	4.94	0.0	0.735	.0080	-.163
2997	0.73	5.85	1.0	0.860	.0166	-.168
2998	0.73	5.08	1.5	0.917	.0209	-.171

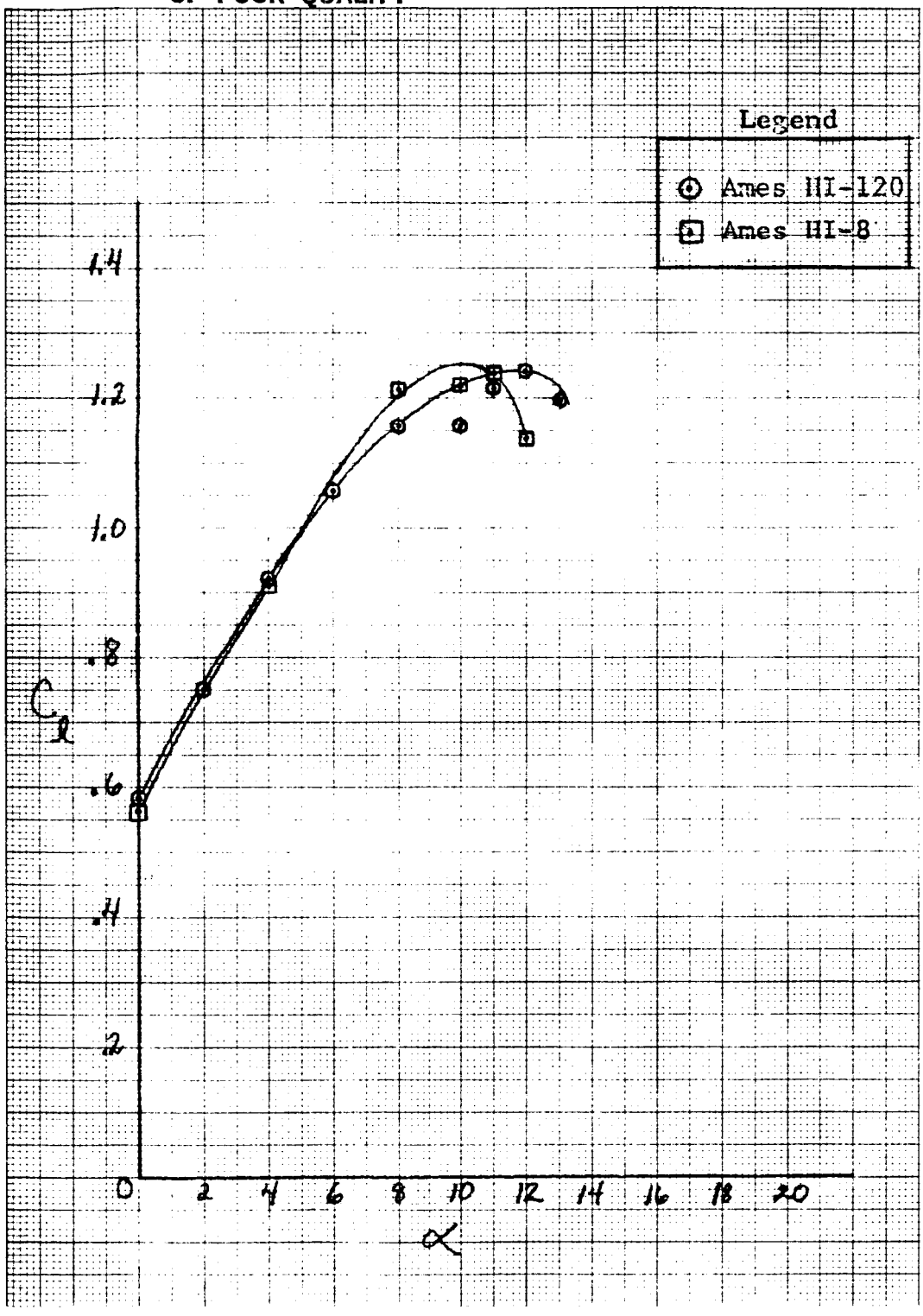


FIGURE 2 LIFT COEFFICIENT VS. ANGLE OF ATTACK
MACH NO. = .200

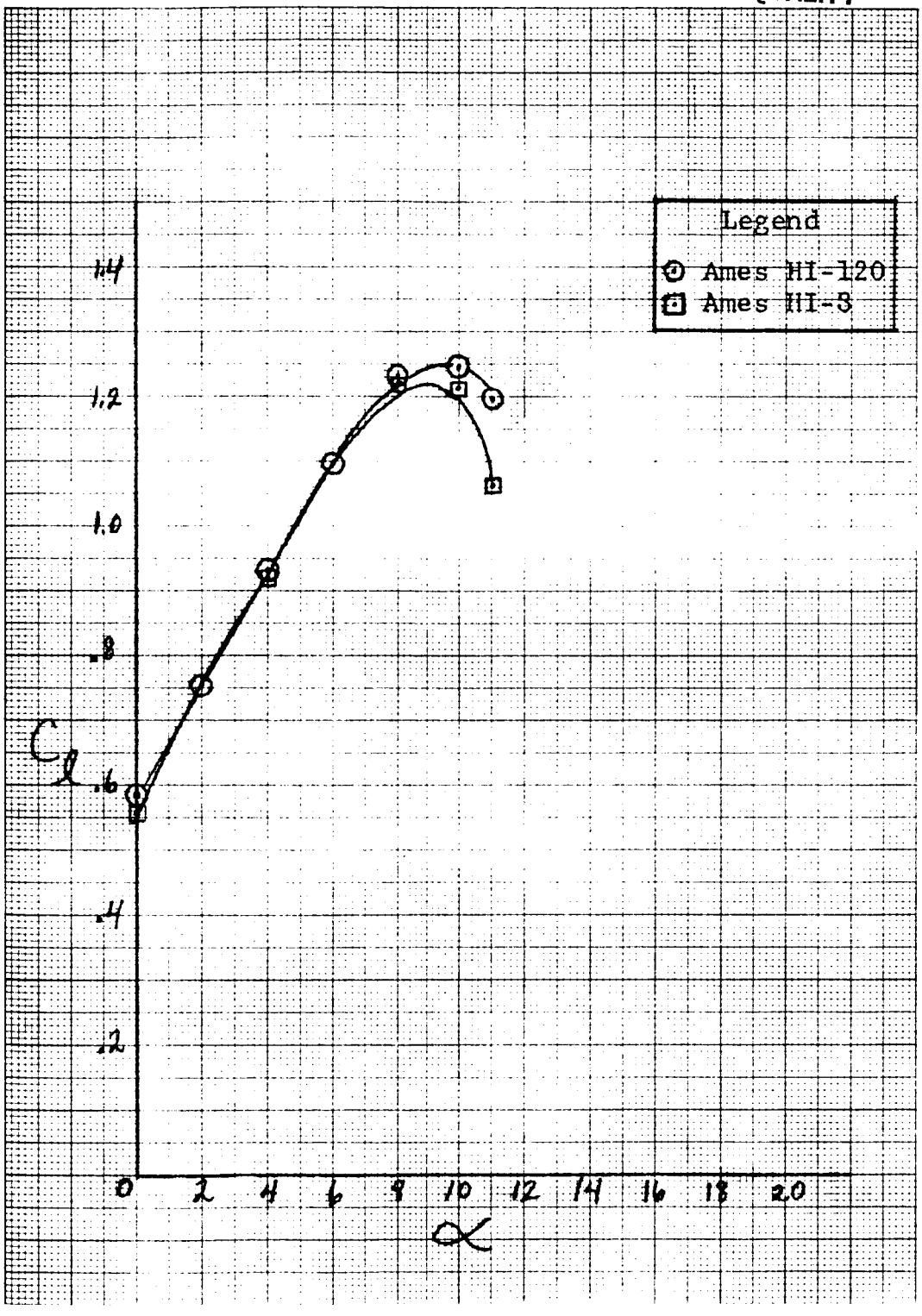


FIGURE 3 LIFT COEFFICIENT VS. ANGLE OF ATTACK
MACH NO. = .400

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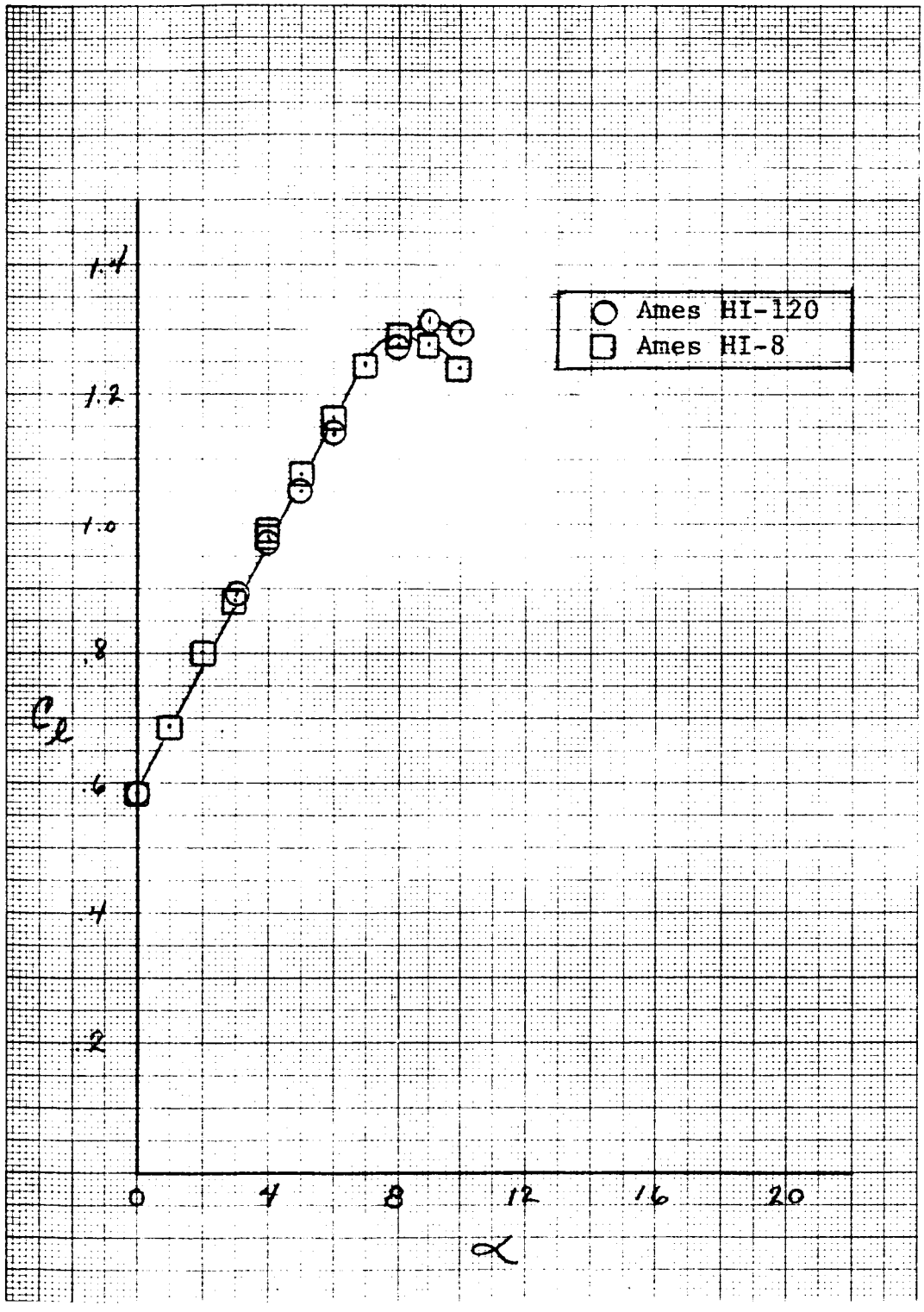

FIGURE 4 LIFT COEFFICIENT VS ANGLE OF ATTACK
MACH NUMBER .500

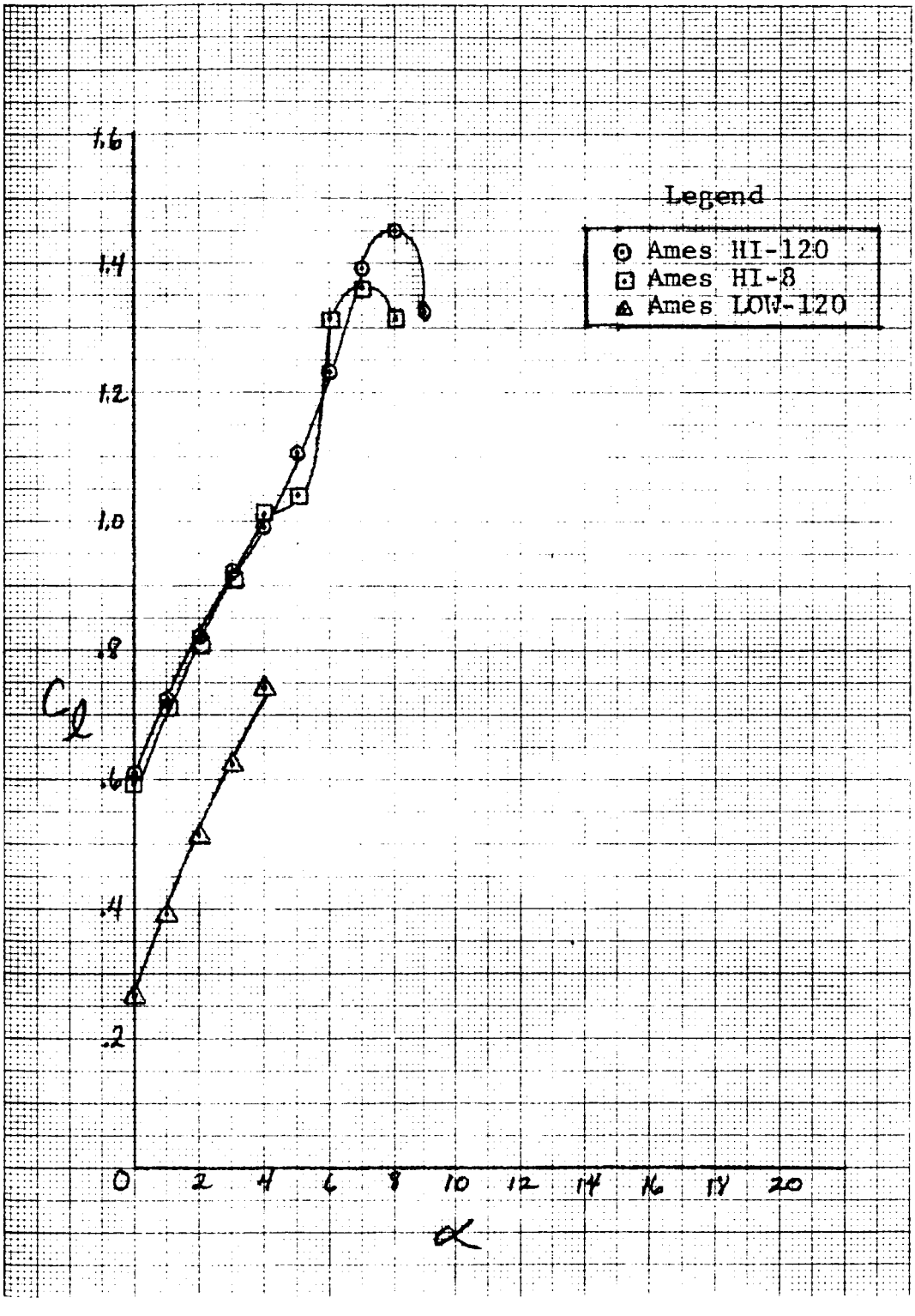

FIGURE 5 LIFT COEFFICIENT VS. ANGLE OF ATTACK
MACH NO. = .600

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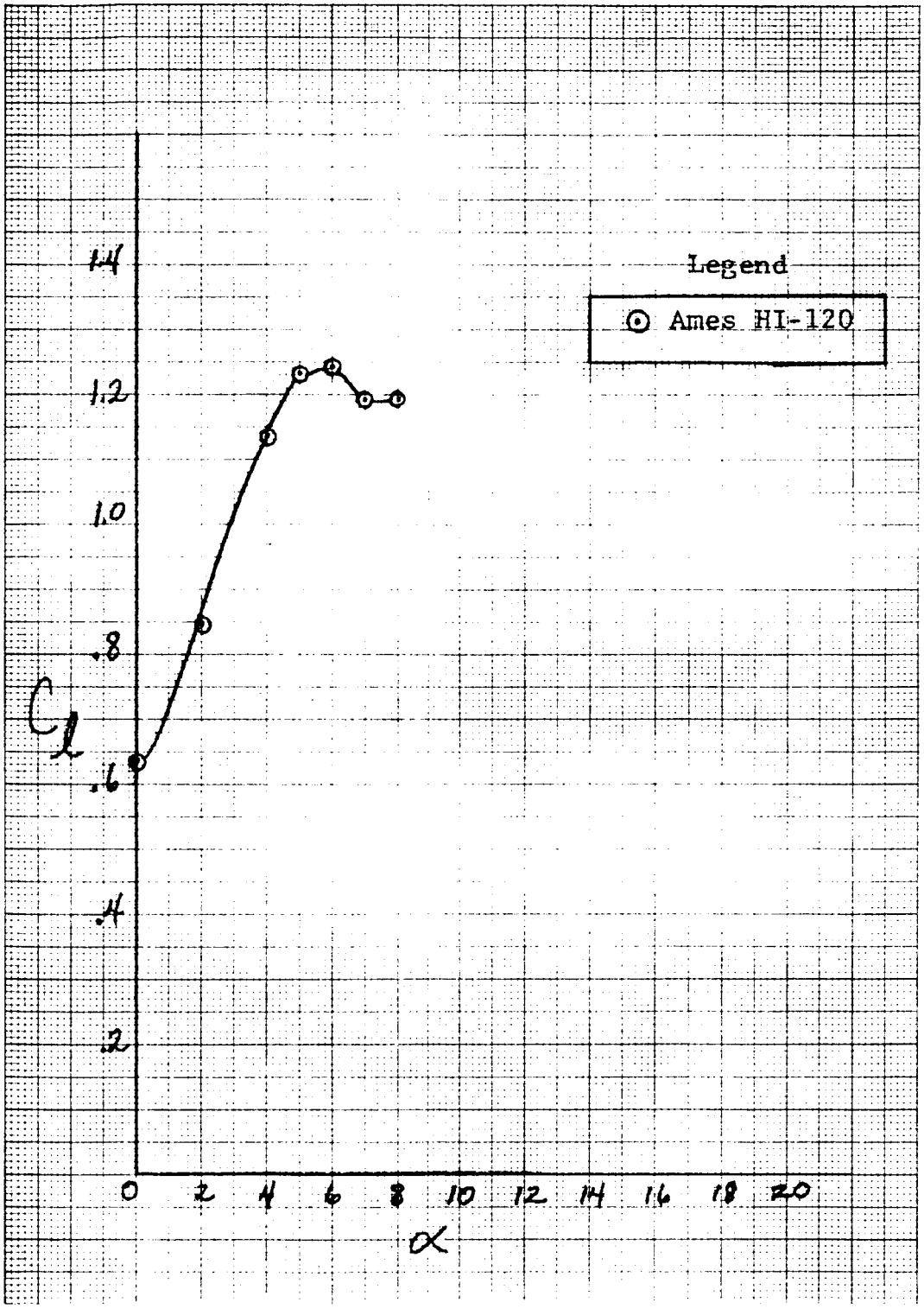

FIGURE 6 LIFT COEFFICIENT VS. ANGLE OF ATTACK
MACH NO. = .650

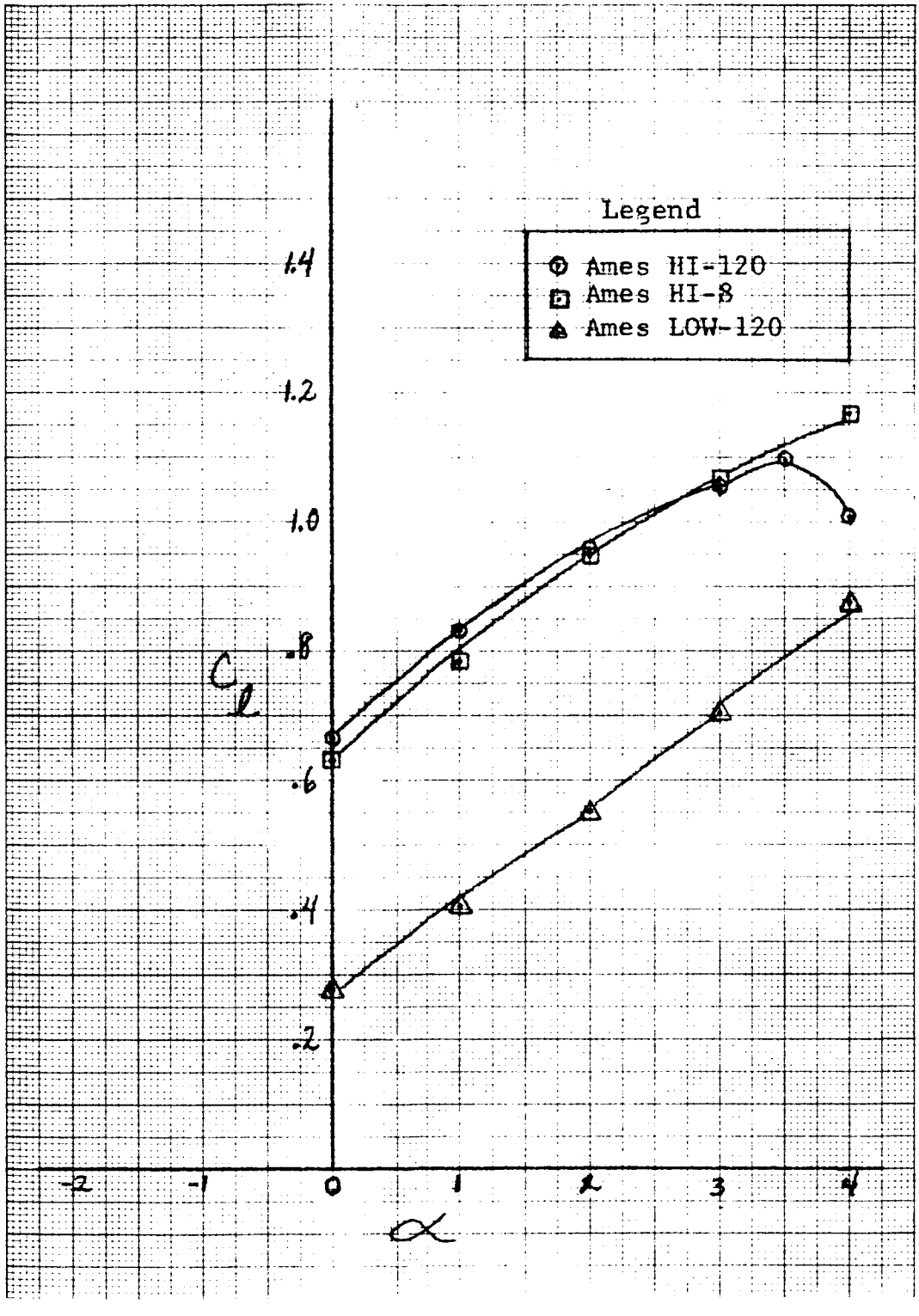

FIGURE 7 LIFT COEFFICIENT VS. ANGLE OF ATTACK
MACH NO. = .700

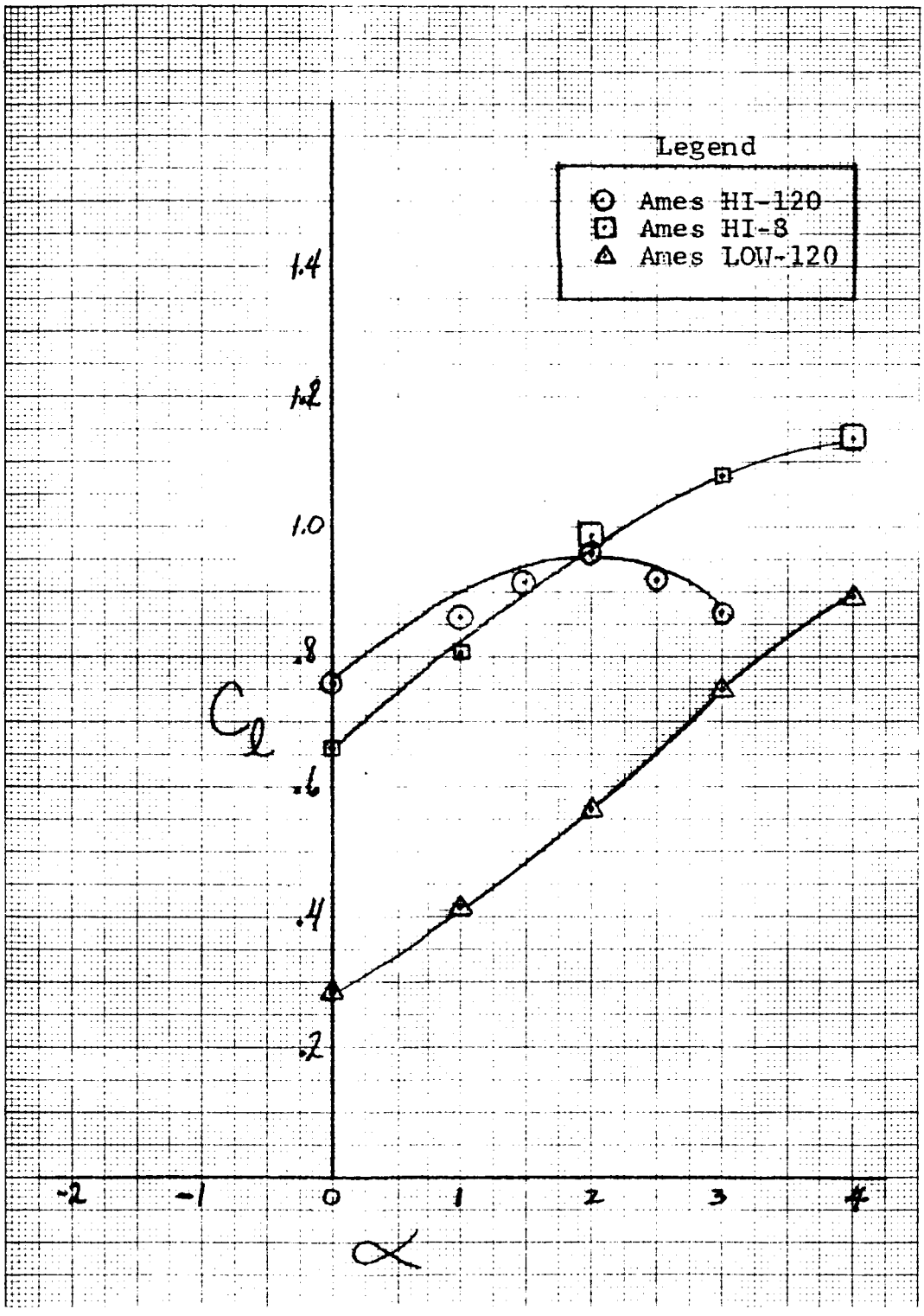

FIGURE 8 LIFT COEFFICIENT VS. ANGLE OF ATTACK
MACH NO. = .725

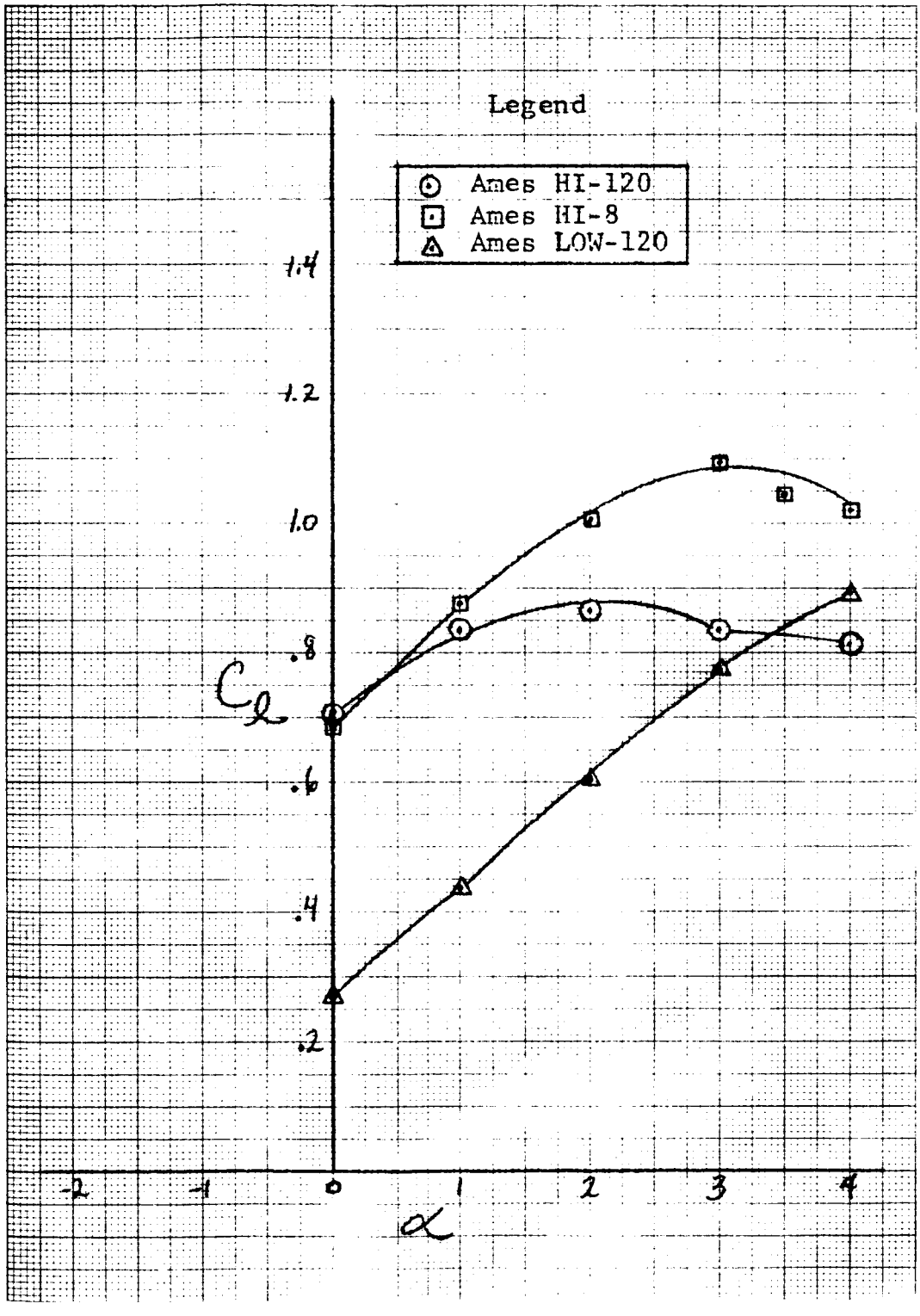

FIGURE 9 LIFT COEFFICIENT VS. ANGLE OF ATTACK
MACH NO. .750

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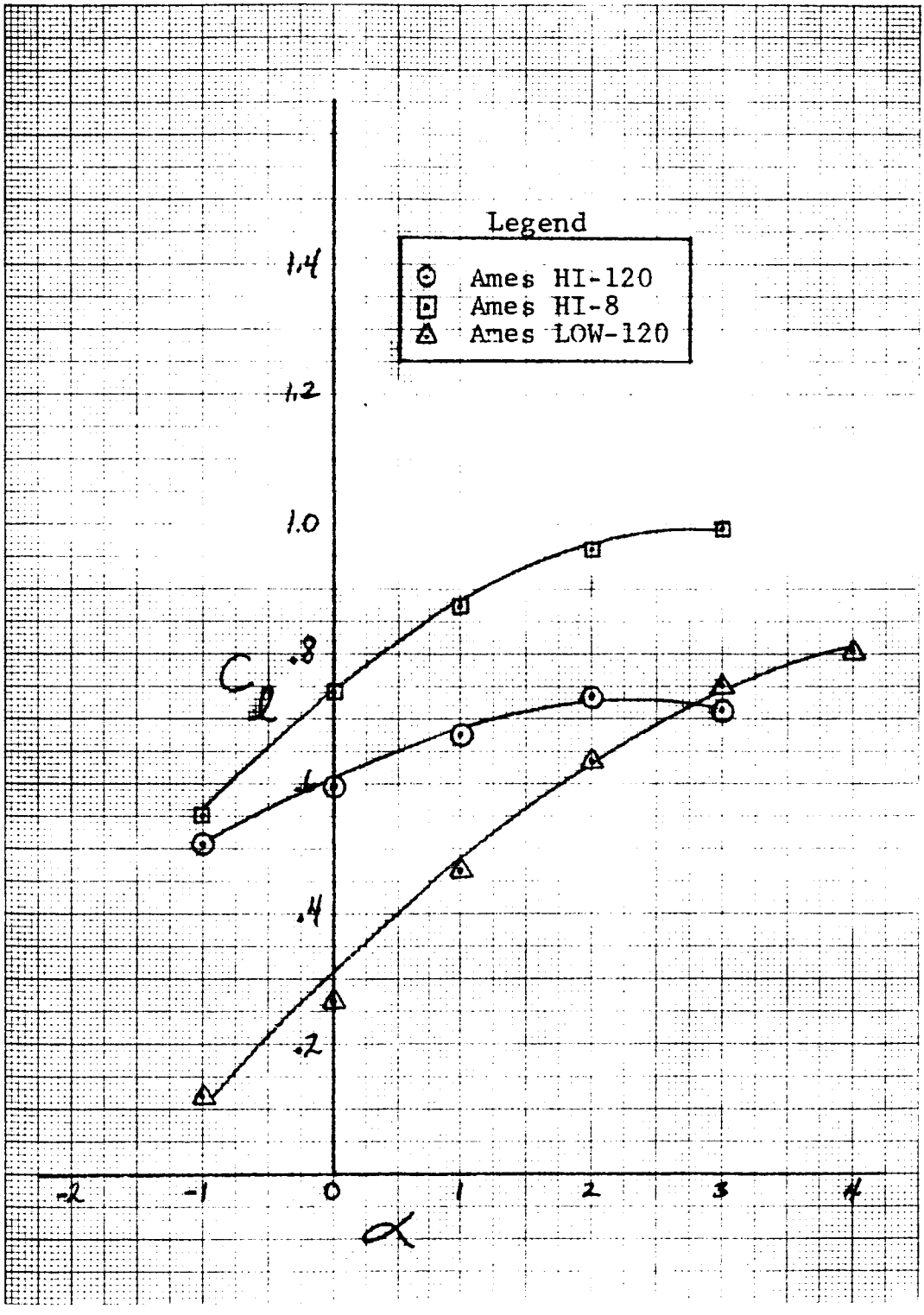

FIGURE 10 LIFT COEFFICIENT VS. ANGLE OF ATTACK
MACH NO. = .780

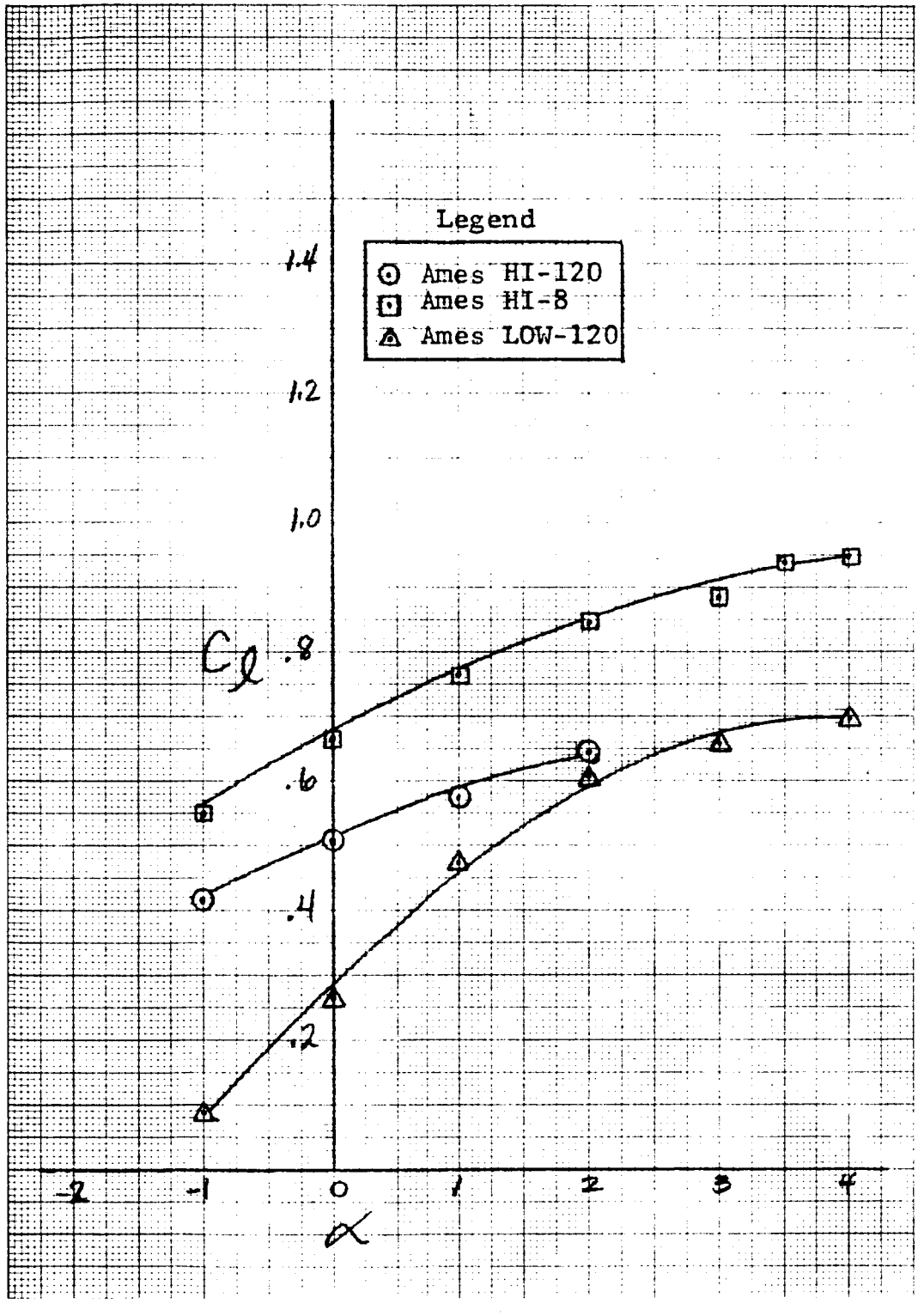

FIGURE 11 LIFT COEFFICIENT VS. ANGLE OF ATTACK
MACH NO. = .300

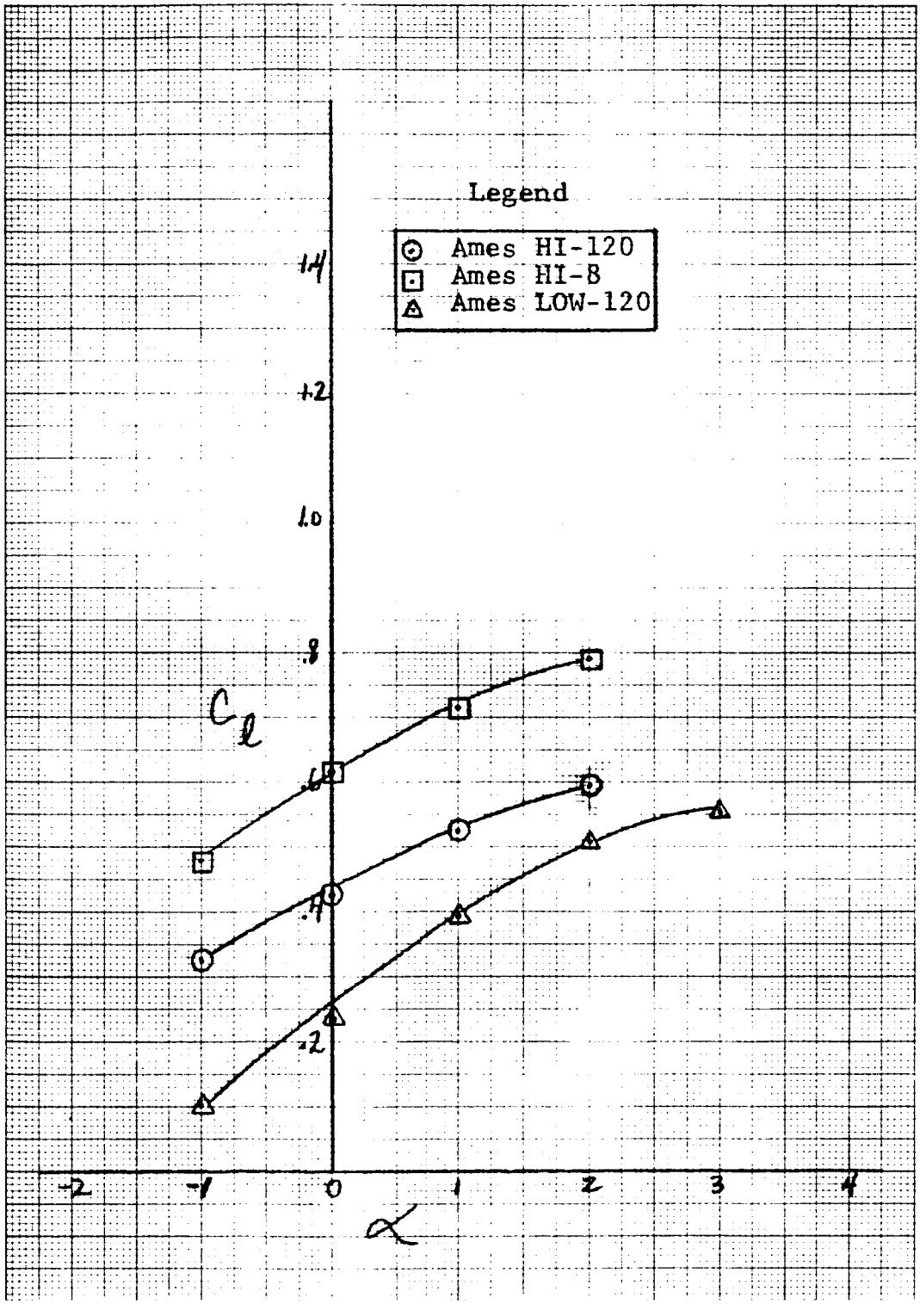

FIGURE 12 LIFT COEFFICIENT VS. ANGLE OF ATTACK
MACH NO. = .820

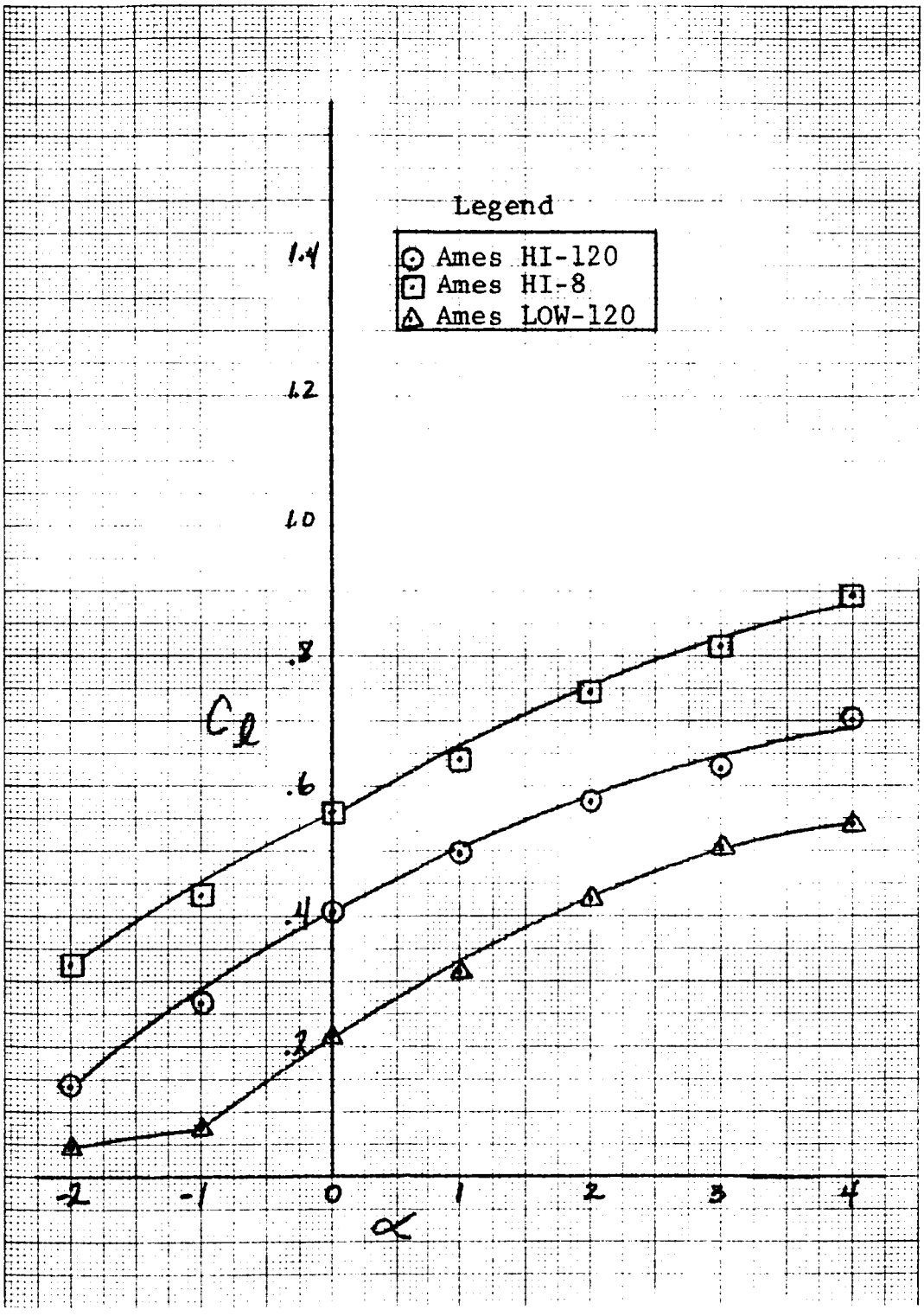

FIGURE 13 LIFT COEFFICIENT VS. ANGLE OF ATTACK
MACH NO. = .840

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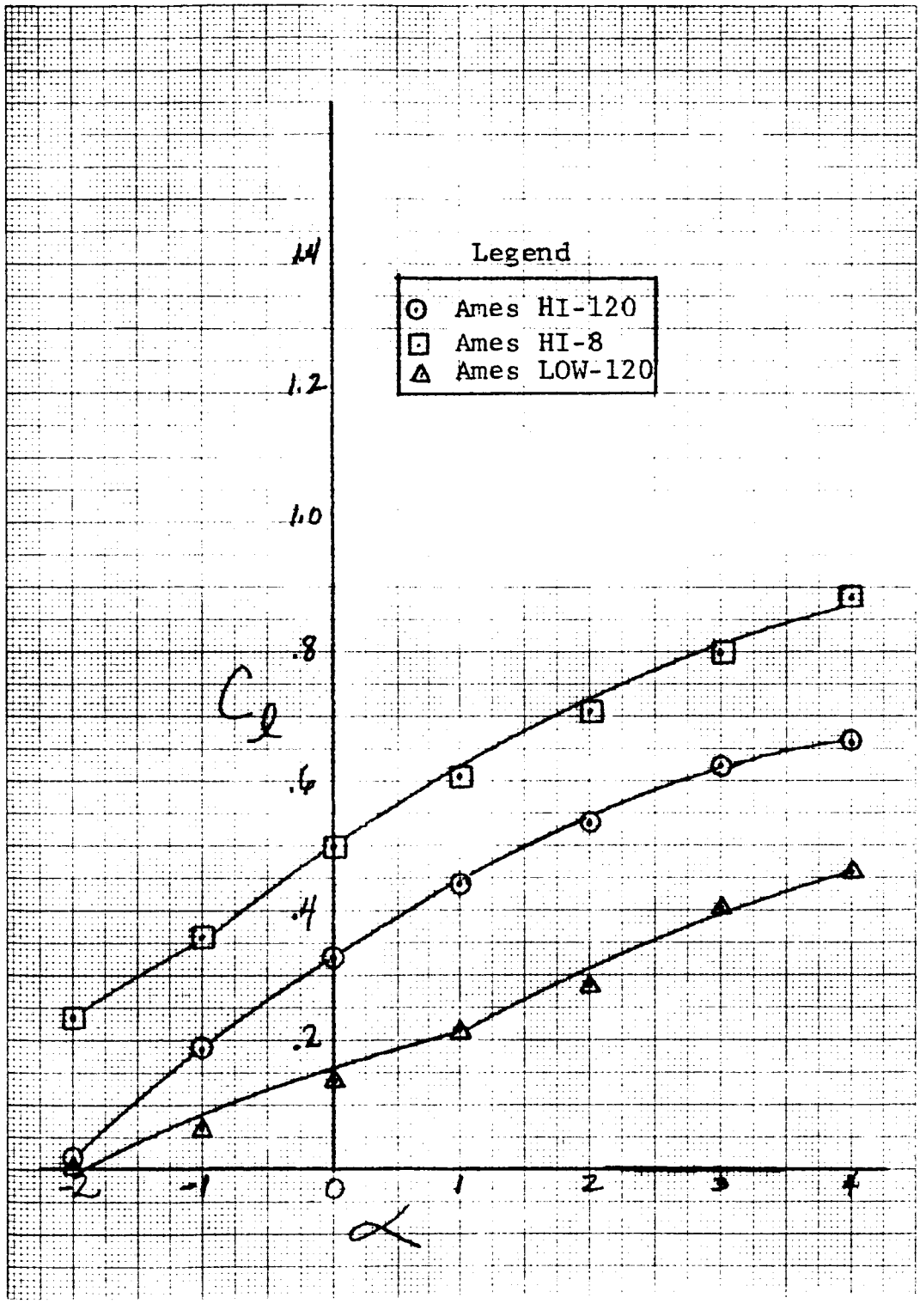

FIGURE 14 LIFT COEFFICIENT VS. ANGLE OF ATTACK
MACH. NO. = .860

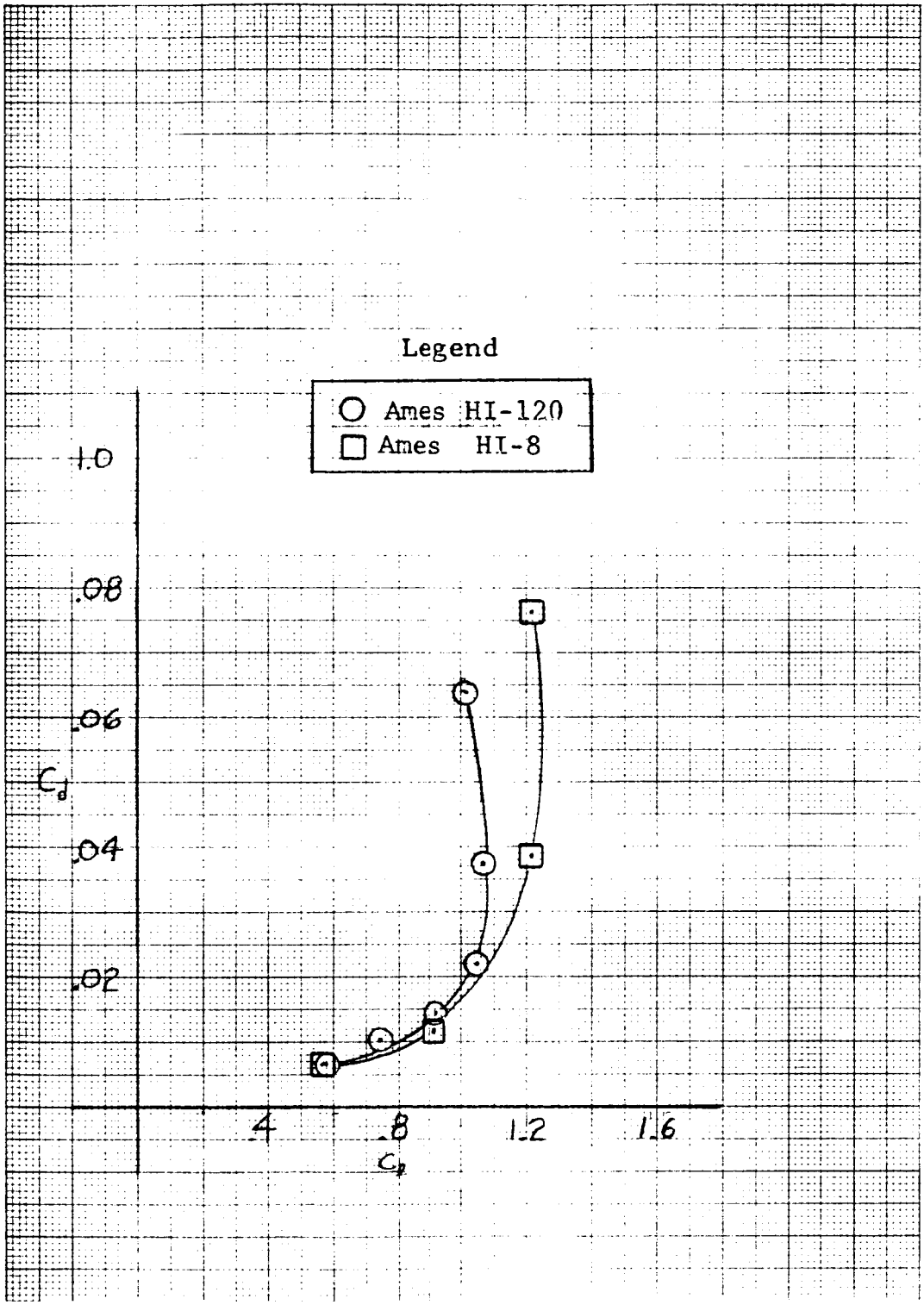

FIGURE 15 DRAG COEFFICIENT VS. LIFT COEFFICIENT
MACH NUMBER = .2

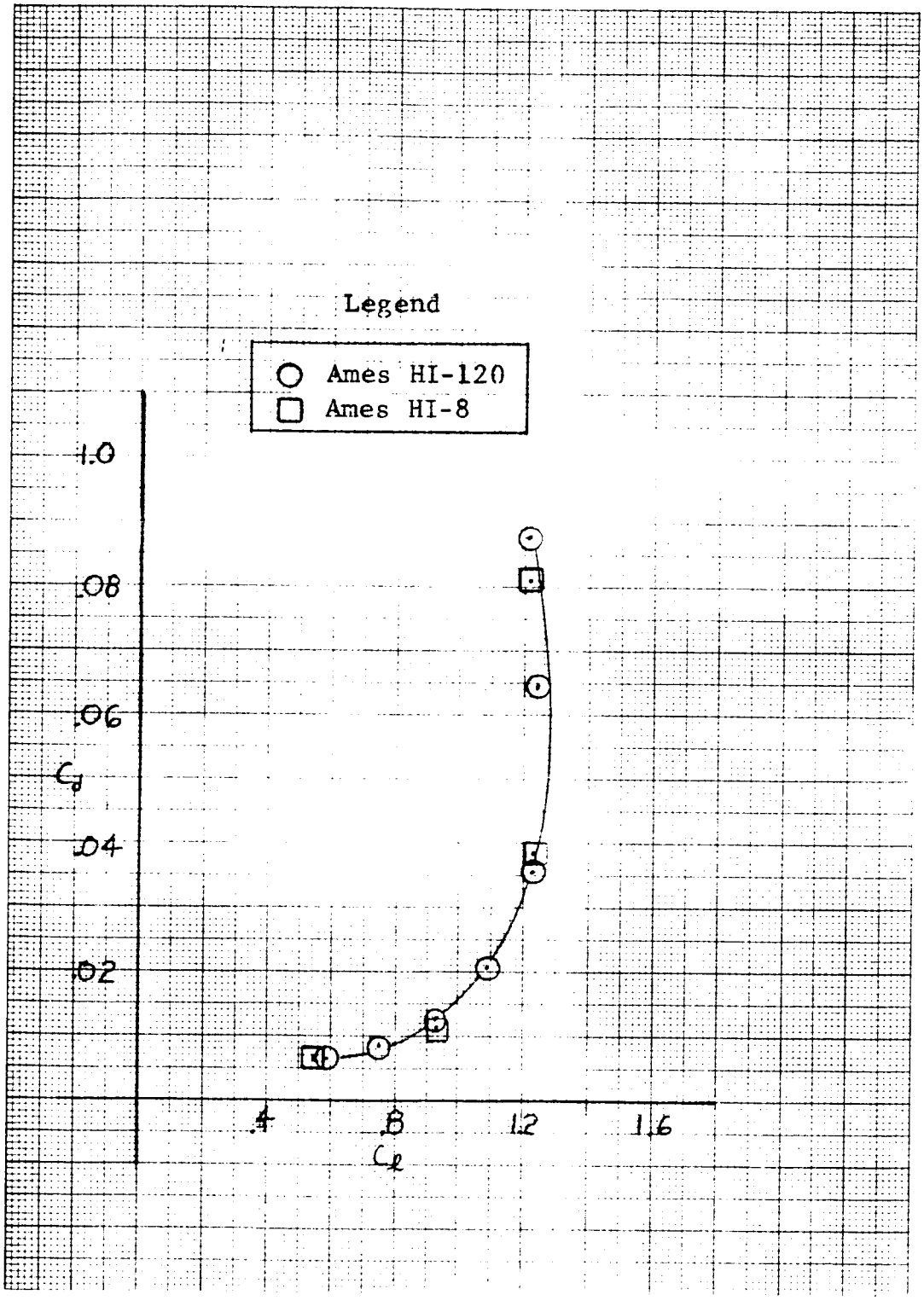

FIGURE 16 DRAG COEFFICIENT VS. LIFT COEFFICIENT
MACH NUMBER = .4

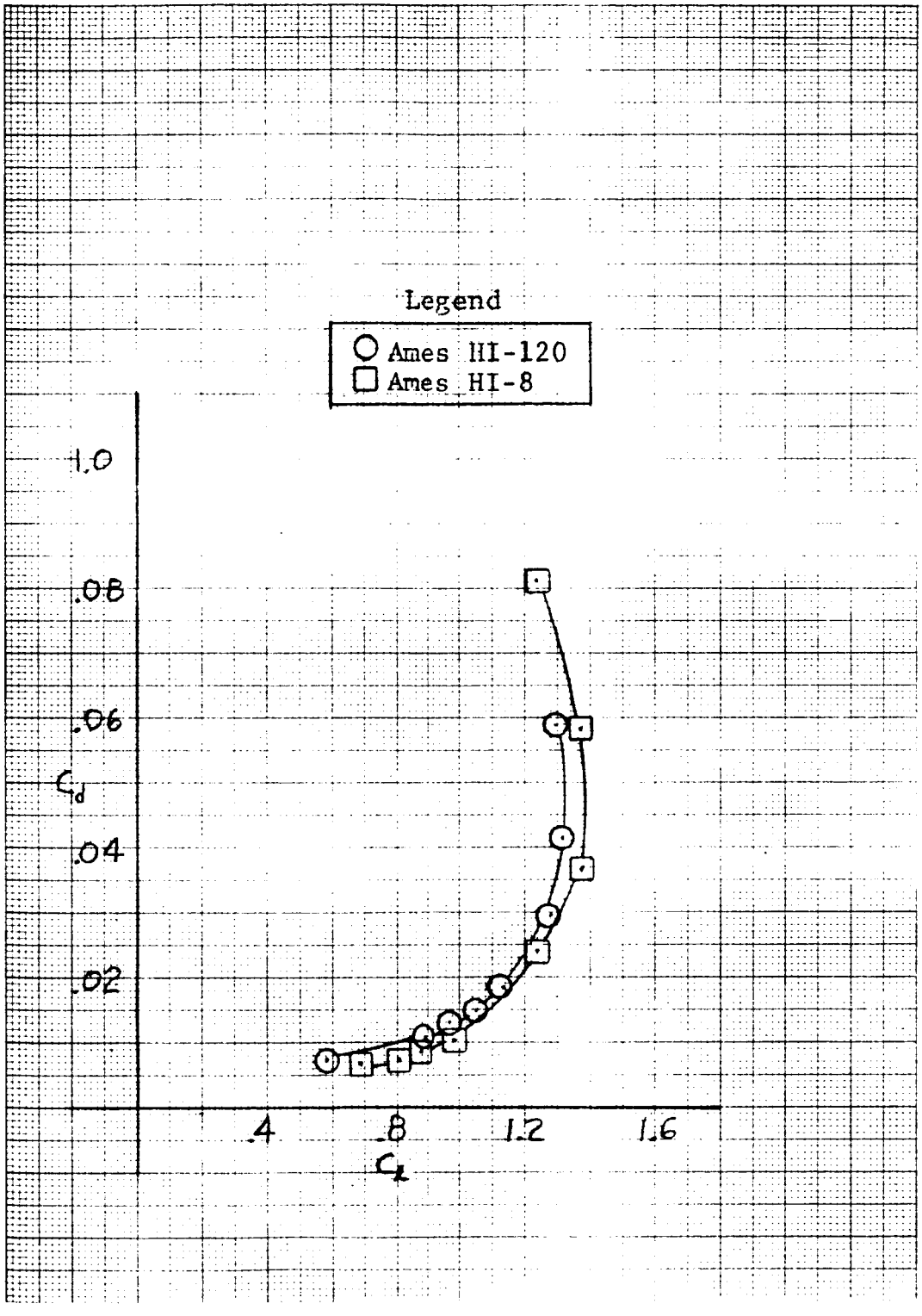

FIGURE 17 DRAG COEFFICIENT VS. LIFT COEFFICIENT
MACH NUMBER = .5

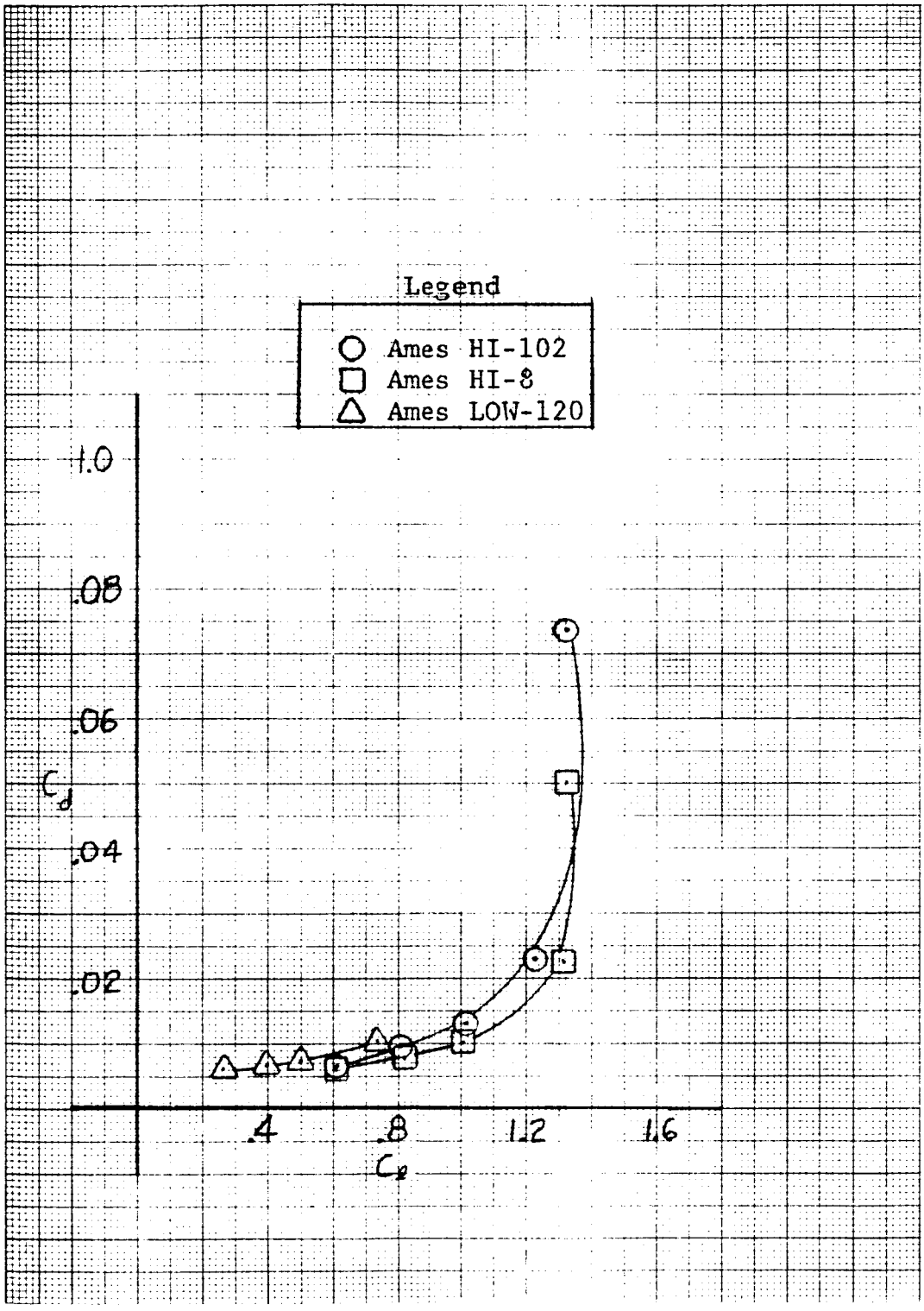

FIGURE 18 DRAG COEFFICIENT VS. LIFT COEFFICIENT
MACH NUMBER = .6

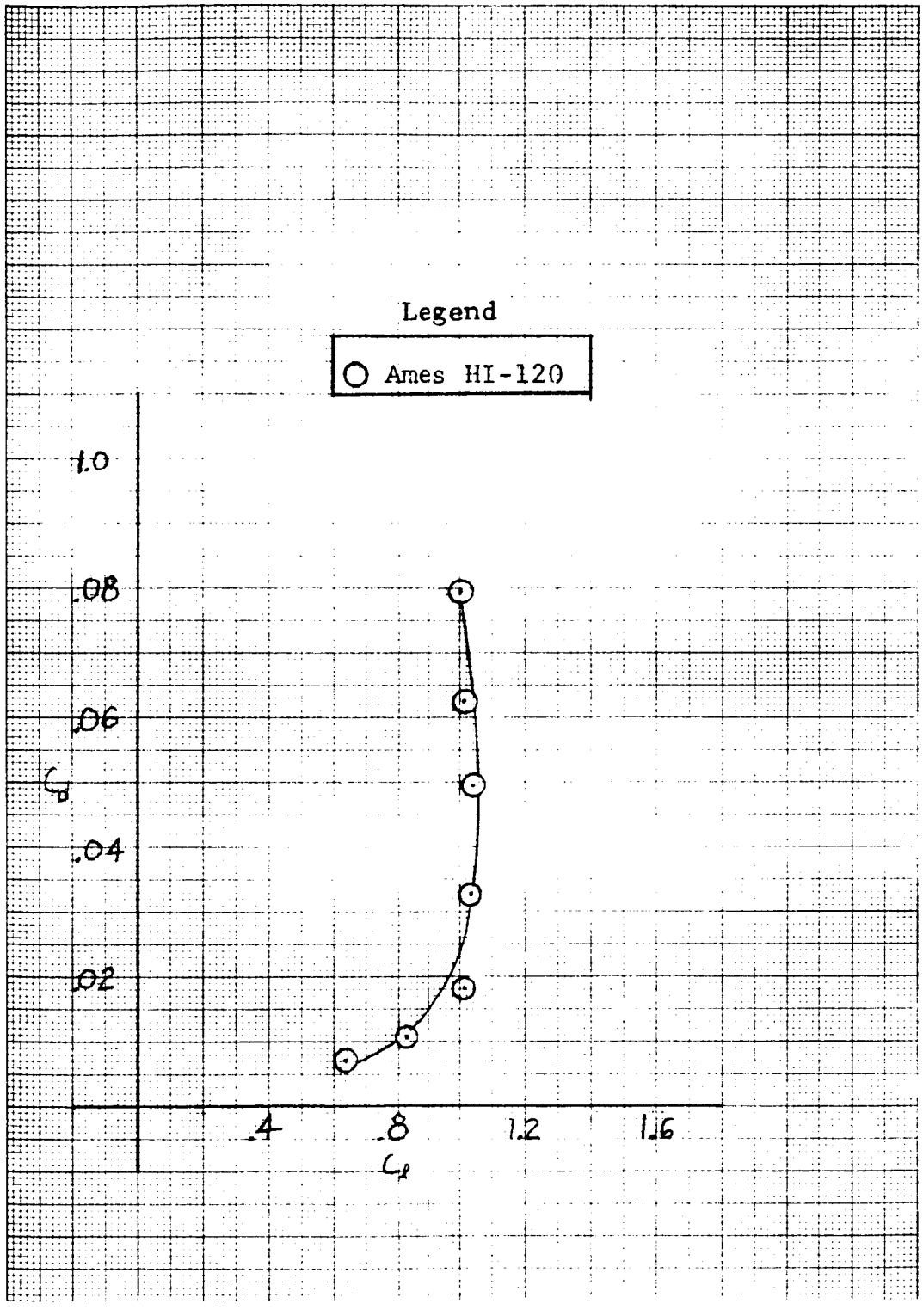

FIGURE 19 DRAG COEFFICIENT VS. LIFT COEFFICIENT
MACH NUMBER = .65

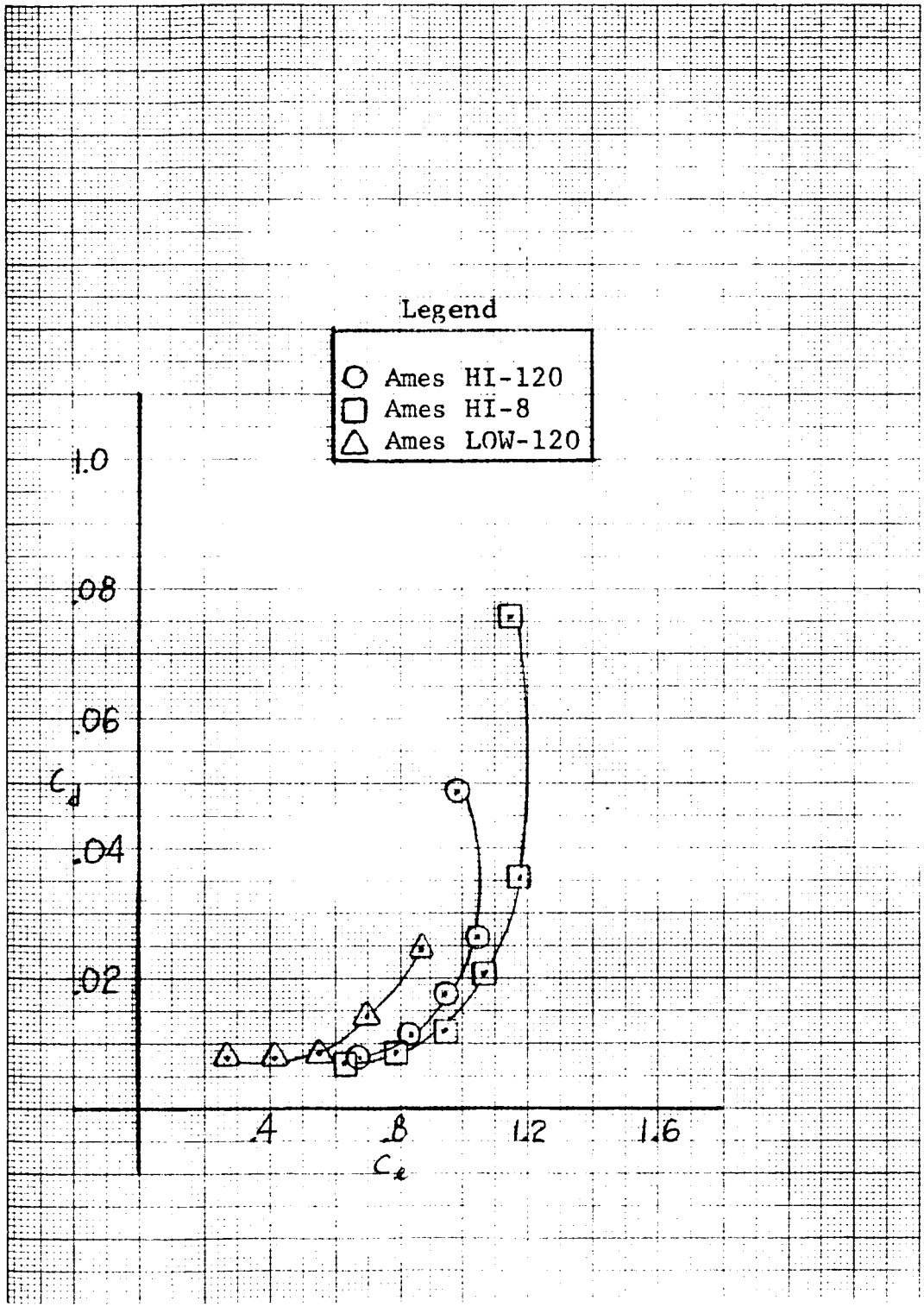

FIGURE 20 DRAG COEFFICIENT VS. LIFT COEFFICIENT
MACH NUMBER = .7

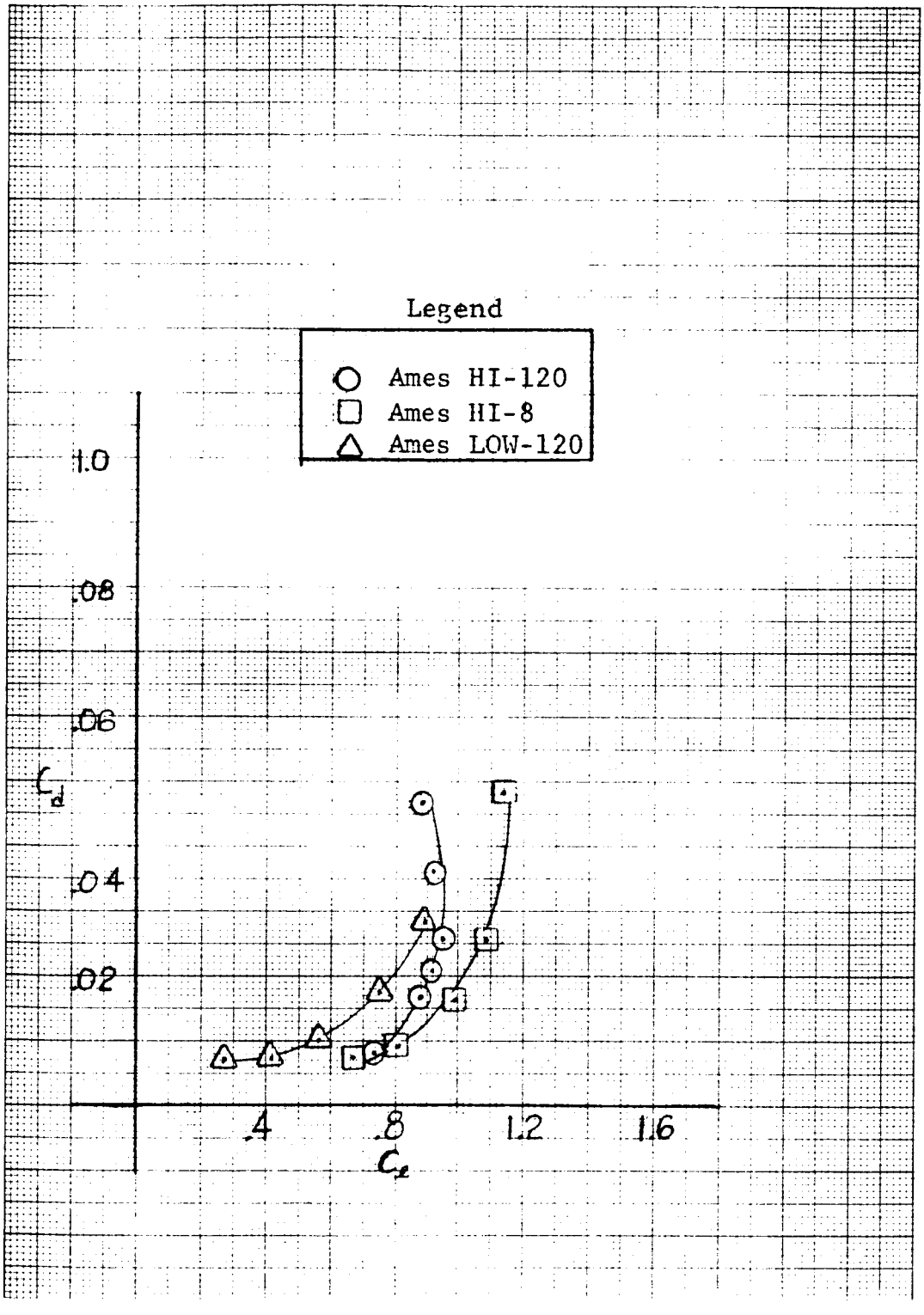

FIGURE 21 DRAG COEFFICIENT VS LIFT COEFFICIENT
MACH NUMBER = .725

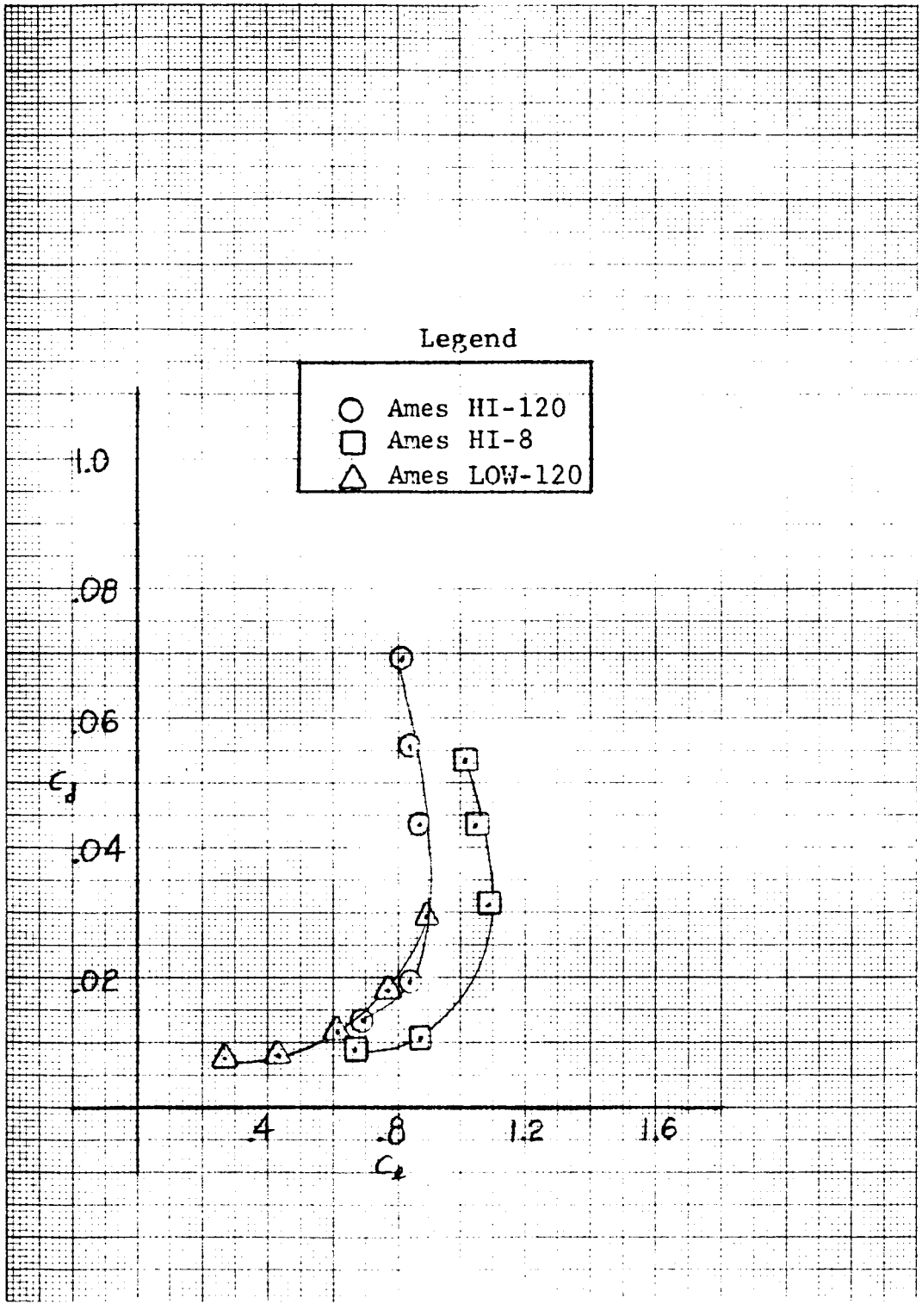

FIGURE 22 DRAG COEFFICIENT VS. LIFT COEFFICIENT
MACH NUMBER = .75

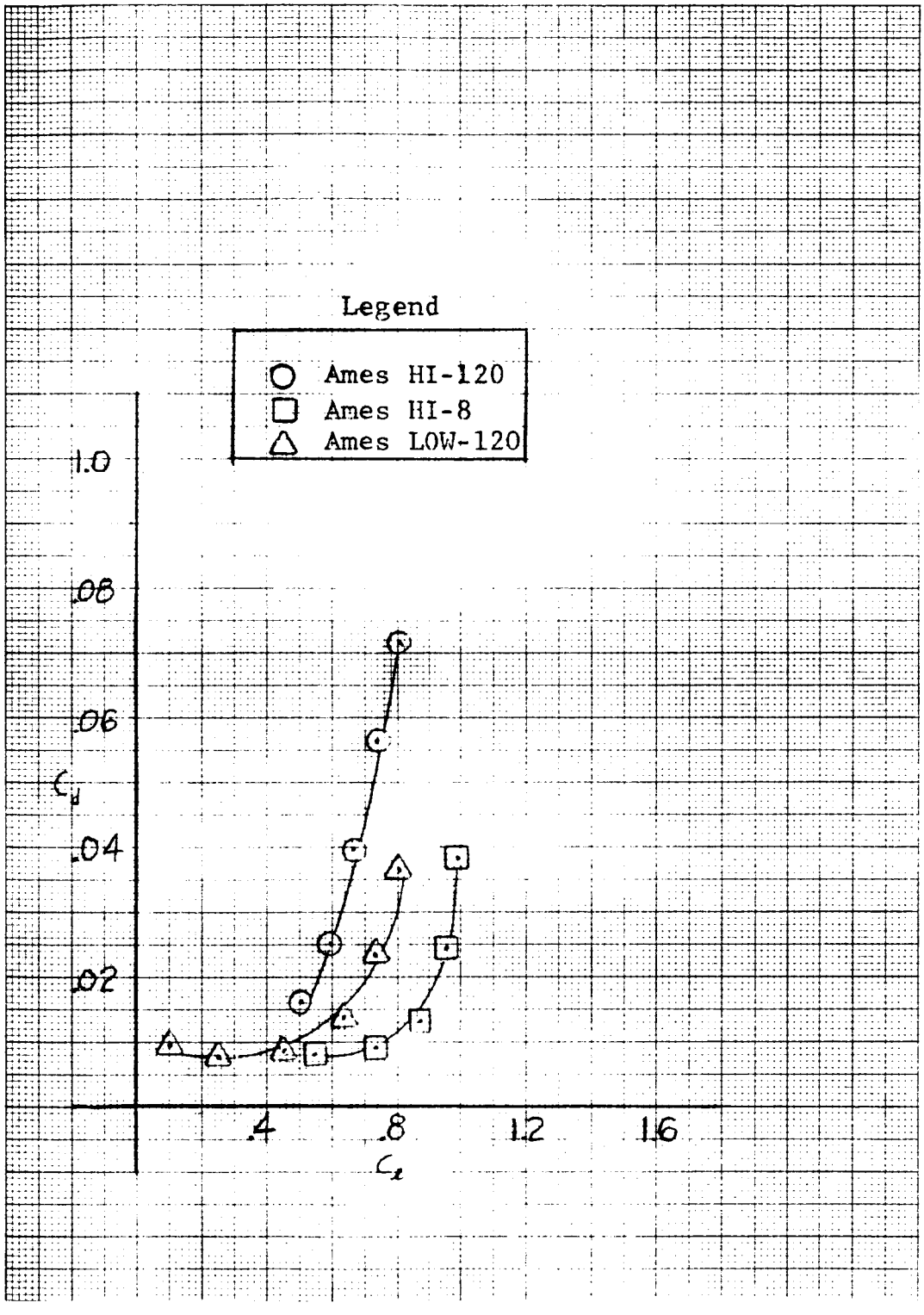

FIGURE 23 DRAG COEFFICIENT VS. LIFT COEFFICIENT
MACH NUMBER = .78

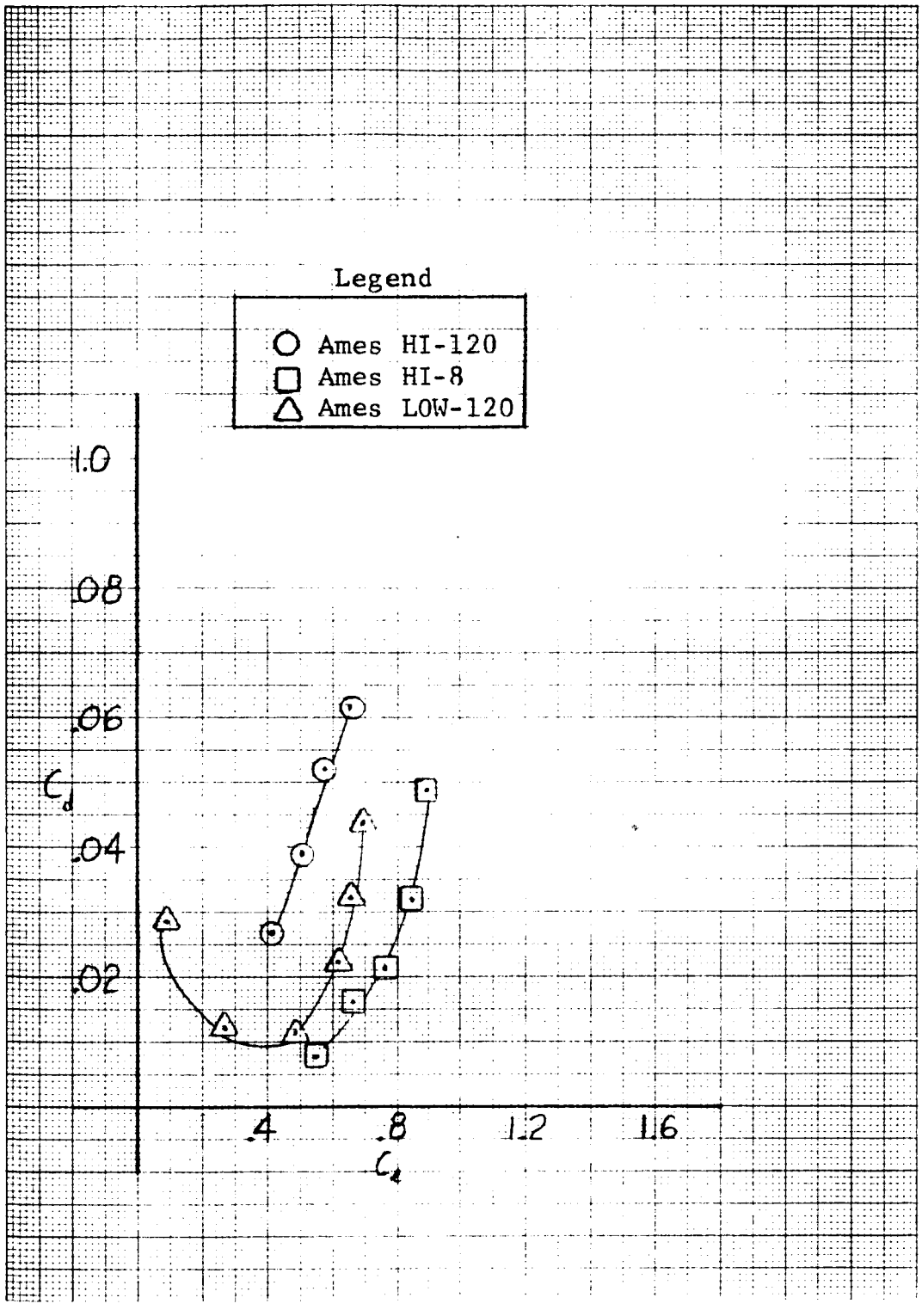

FIGURE 24 DRAG COEFFICIENT VS. LIFT COEFFICIENT
MACH NUMBER = .8

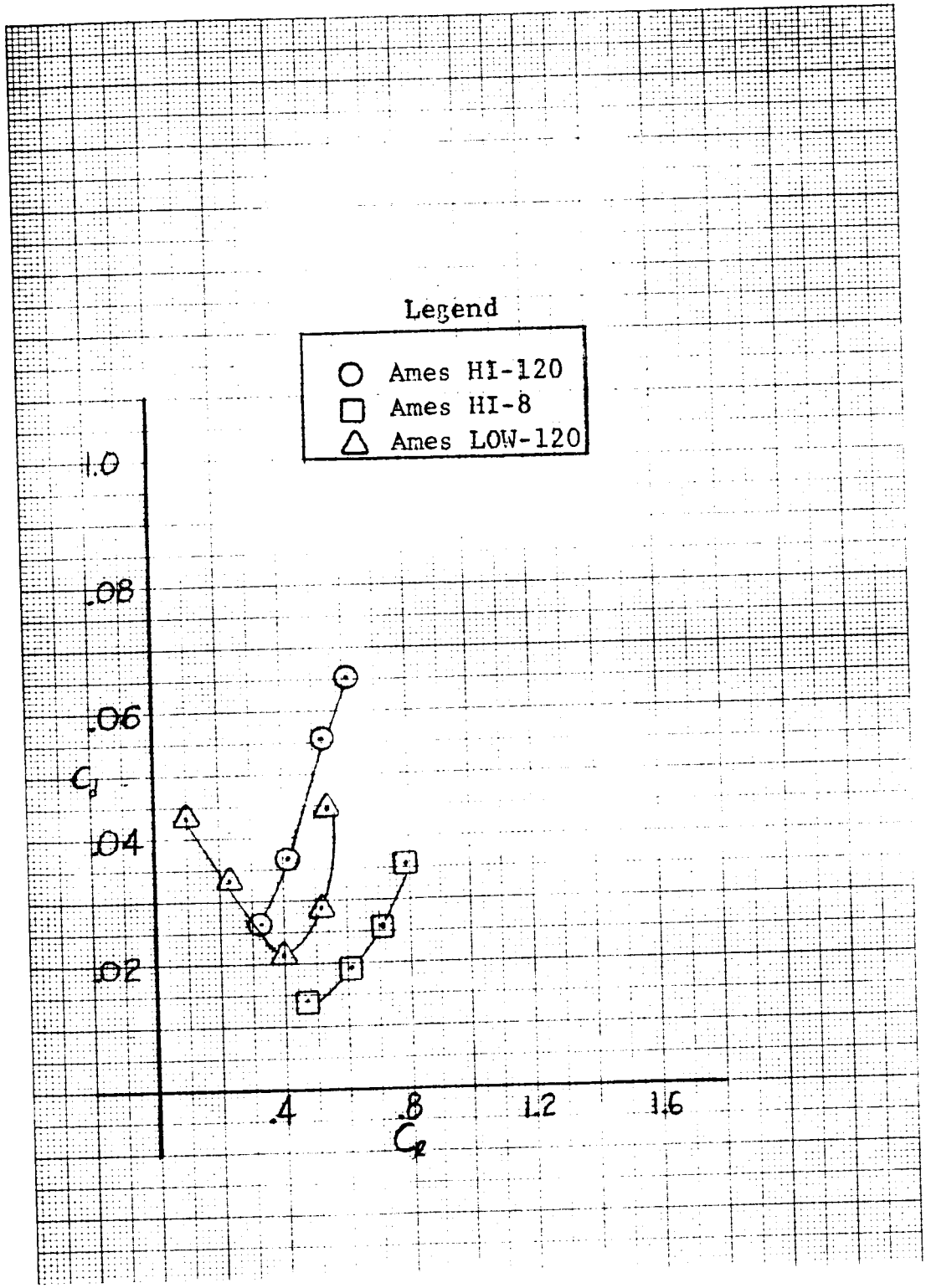

FIGURE 25 DRAG COEFFICIENT VS. LIFT COEFFICIENT
MACH NUMBER = .82

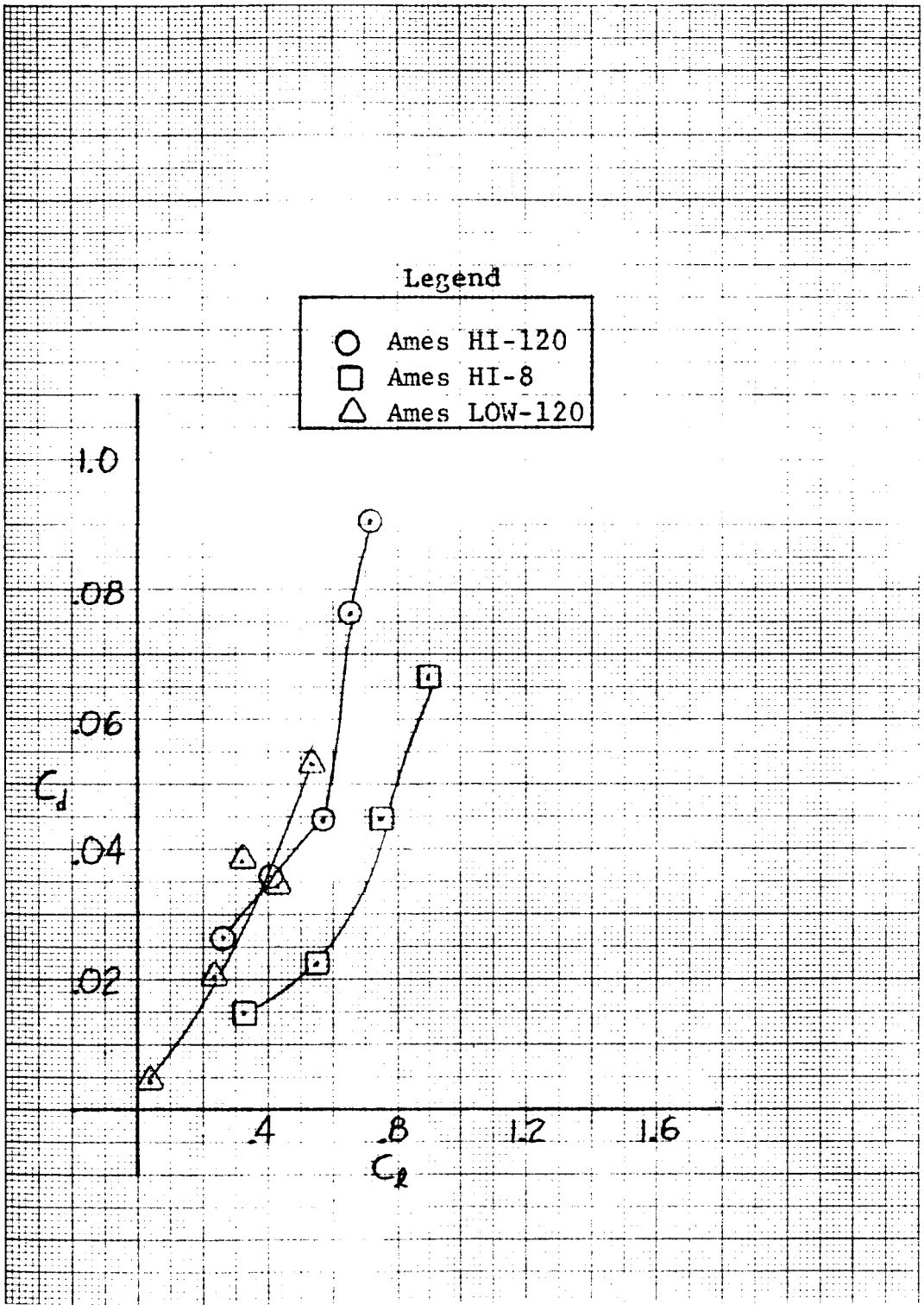

FIGURE 26 DRAG COEFFICIENT VS. LIFT COEFFICIENT
MACH NUMBER = .84

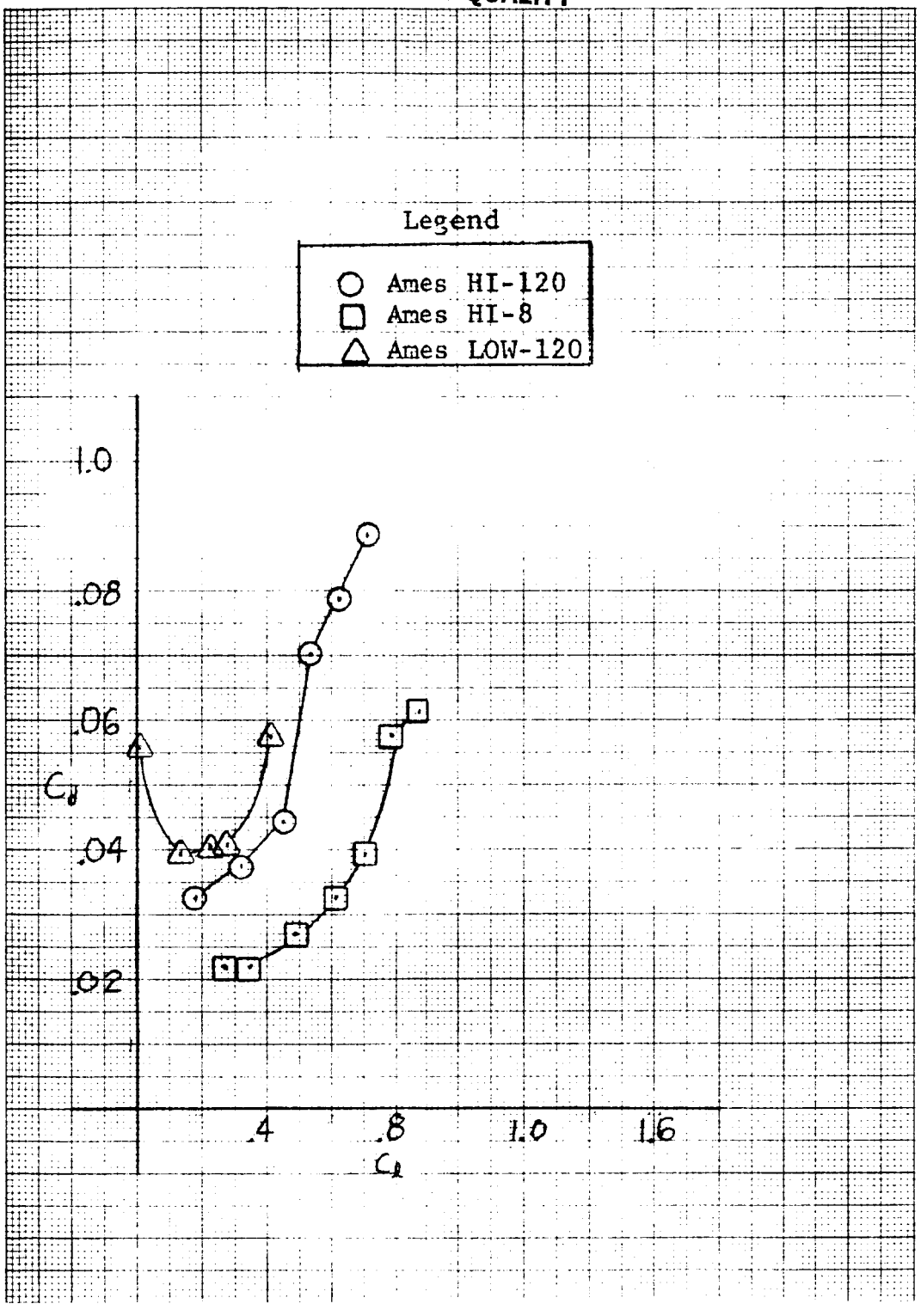

FIGURE 27 DRAG COEFFICIENT VS. LIFT COEFFICIENT
MACH NUMBER = .86

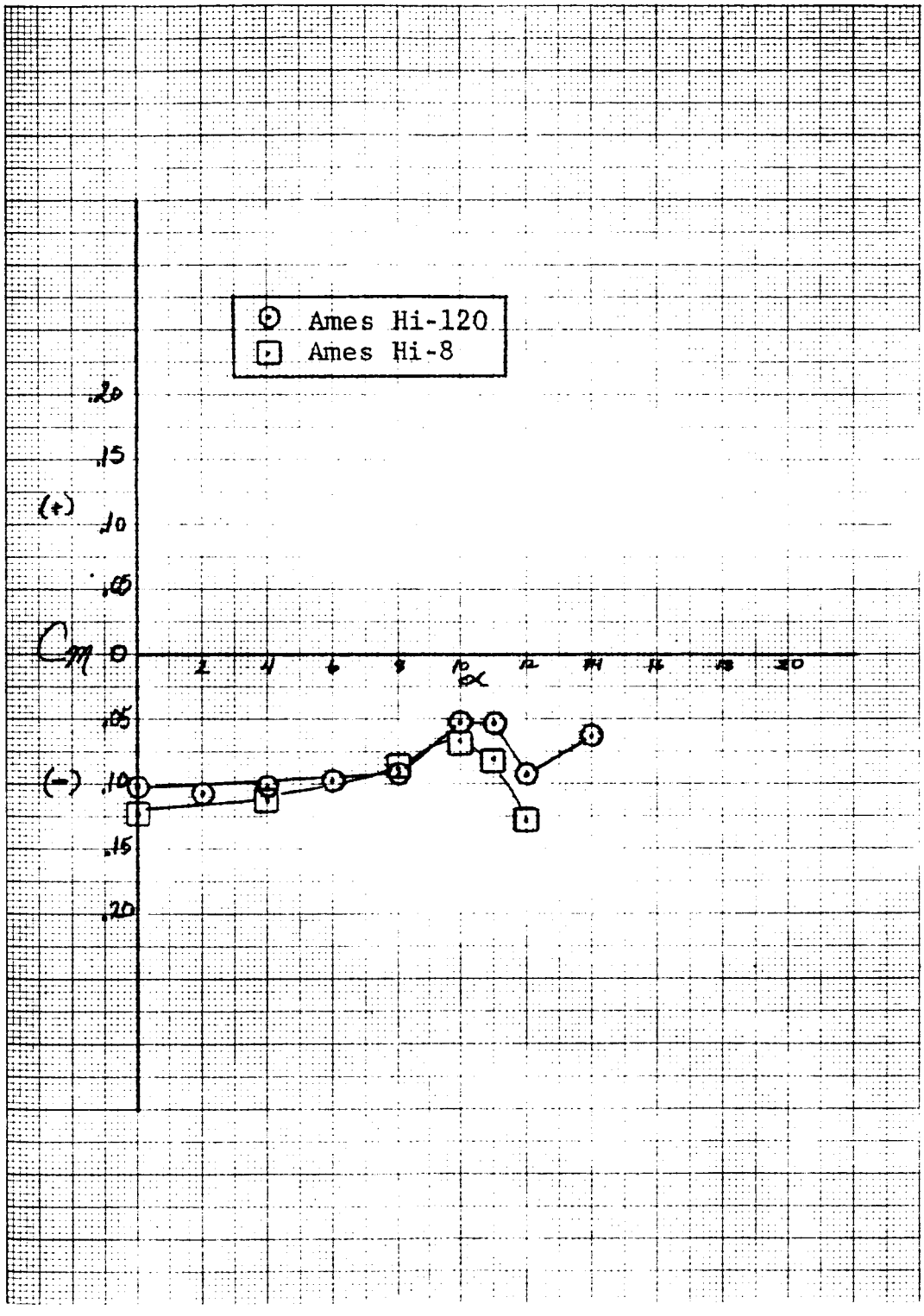

FIGURE 28 MOMENT COEFFICIENT VS. ANGLE OF ATTACK
MACH NUMBER .200

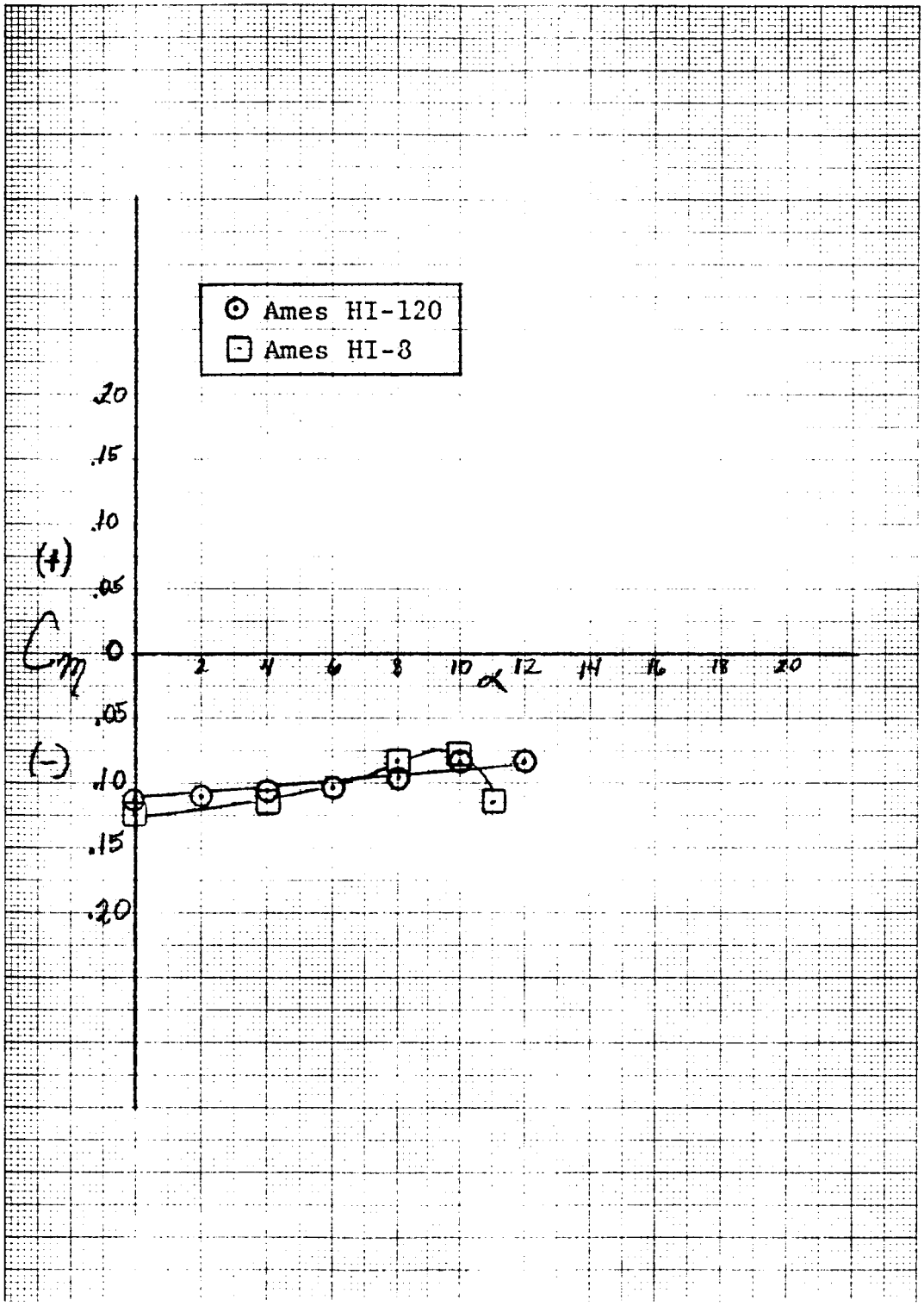

FIGURE 29 MOMENT COEFFICIENT VS. ANGLE OF ATTACK
MACH NUMBER .400

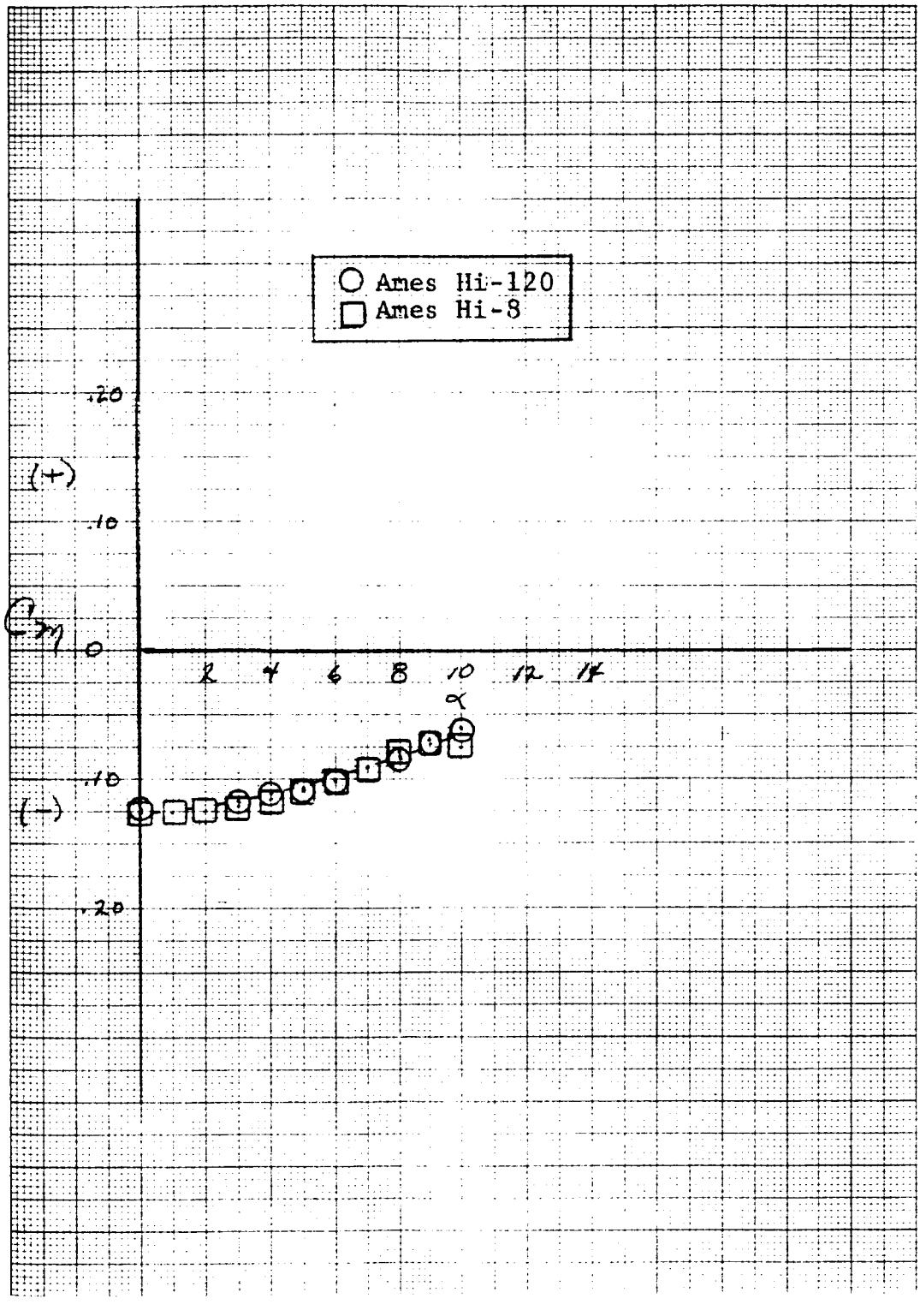

FIGURE 30 MOMENT COEFFICIENT VS. ANGLE OF ATTACK
MACH NUMBER .500

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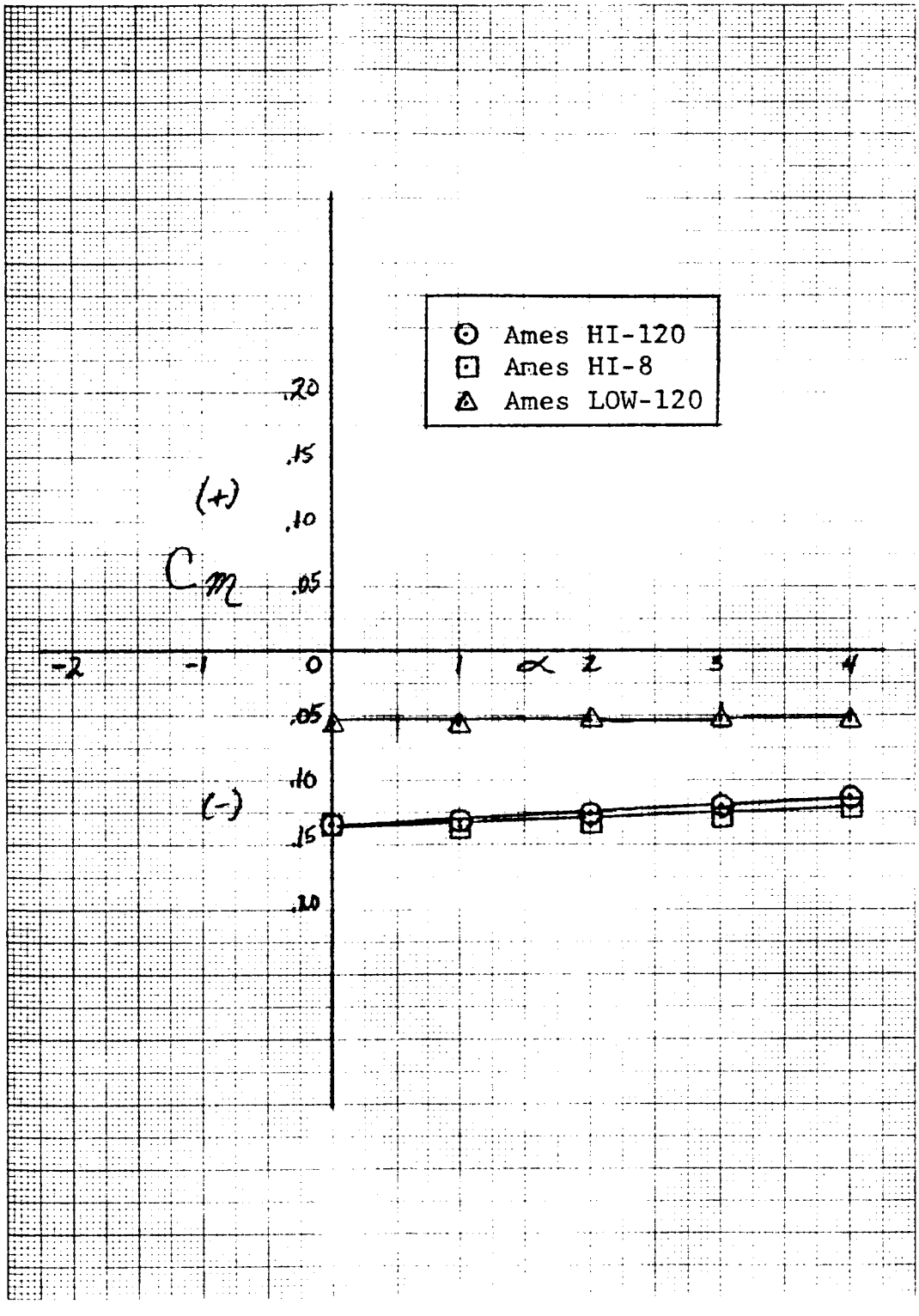

FIGURE 31 MOMENT COEFFICIENT VS. ANGLE OF ATTACK
MACH NUMBER .600

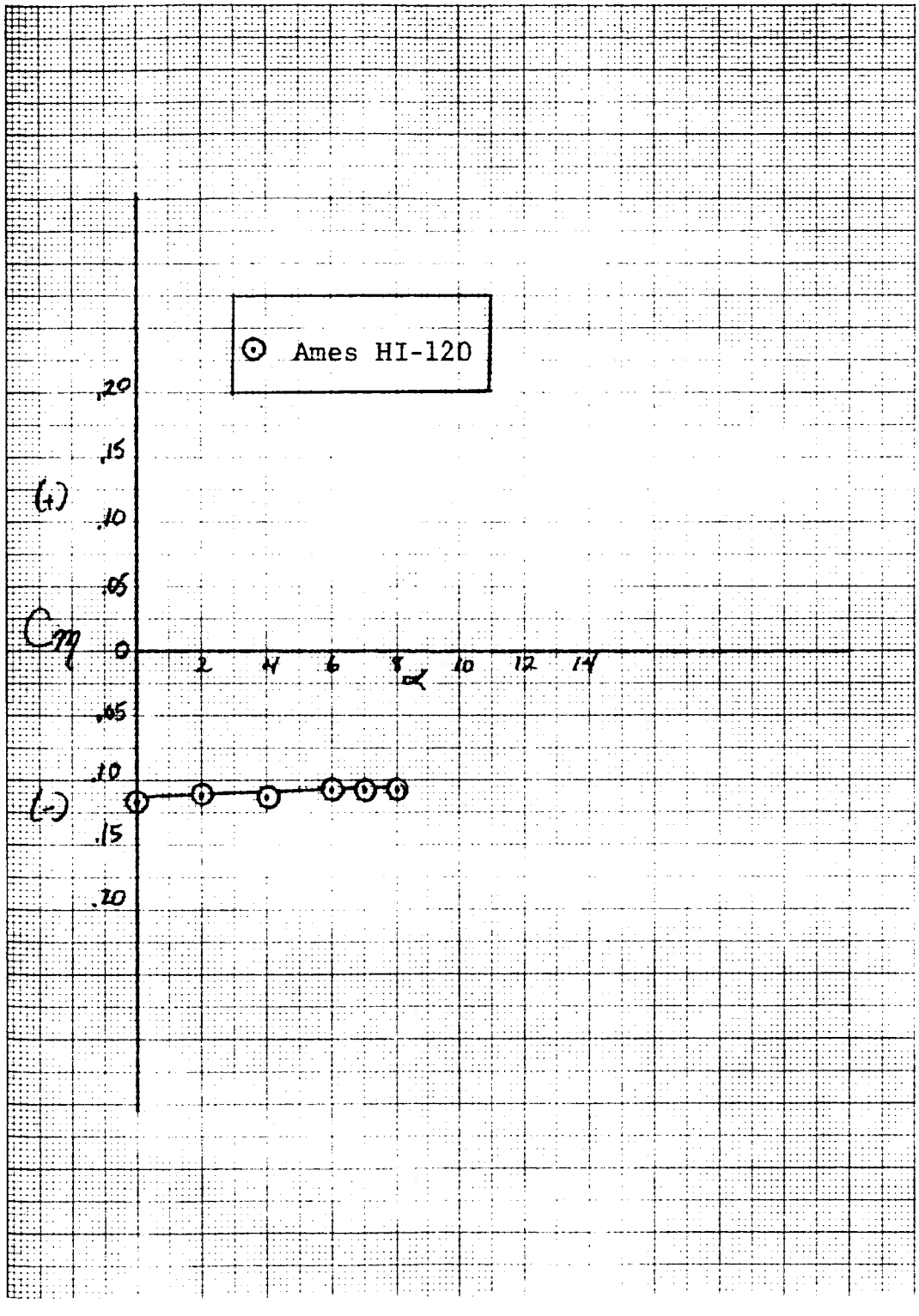

FIGURE 32 MOMENT COEFFICIENT VS. ANGLE OF ATTACK
MACH NUMBER .650

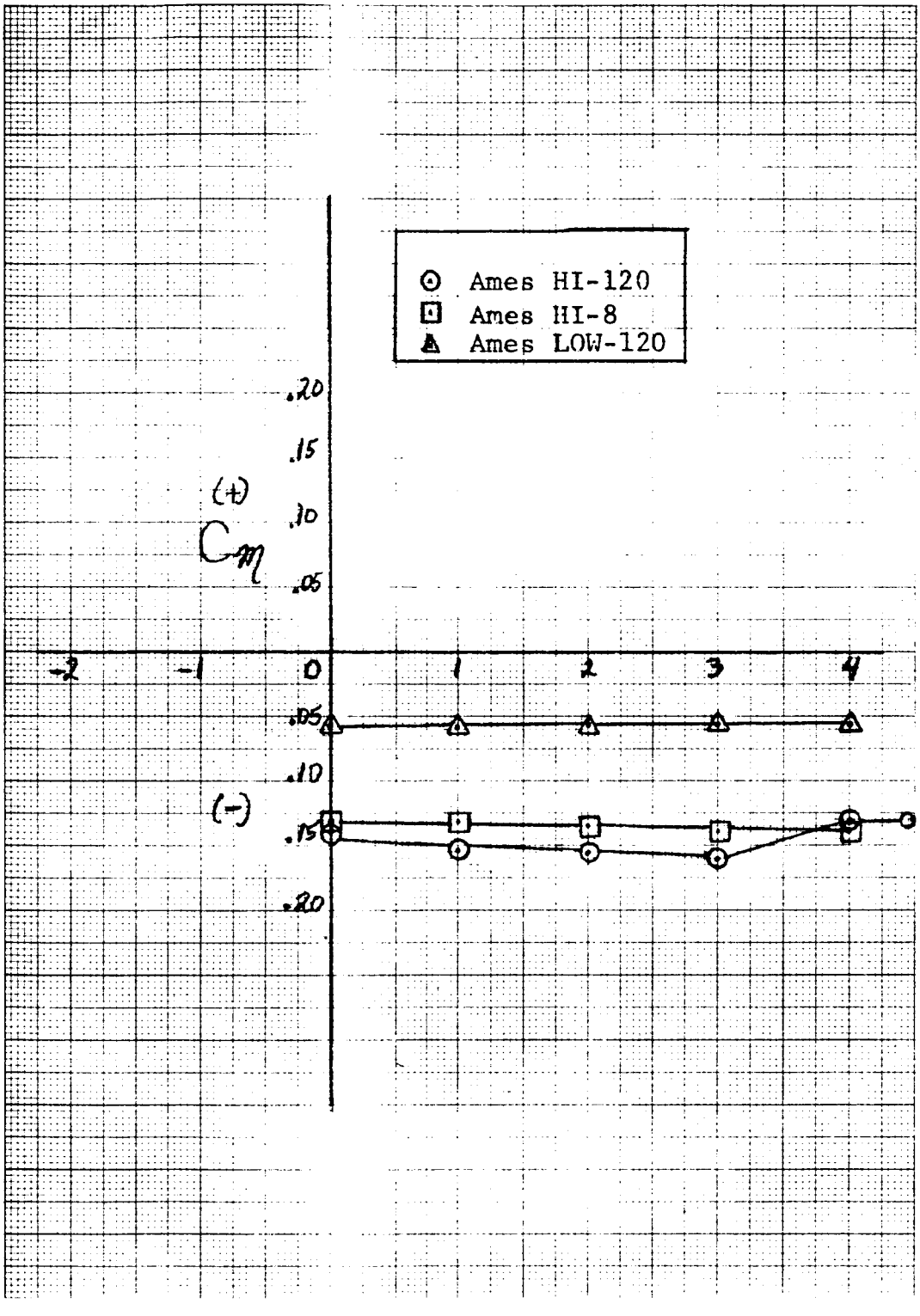

FIGURE 33 MOMENT COEFFICIENT VS. ANGLE OF ATTACK
MACH NUMBER .700

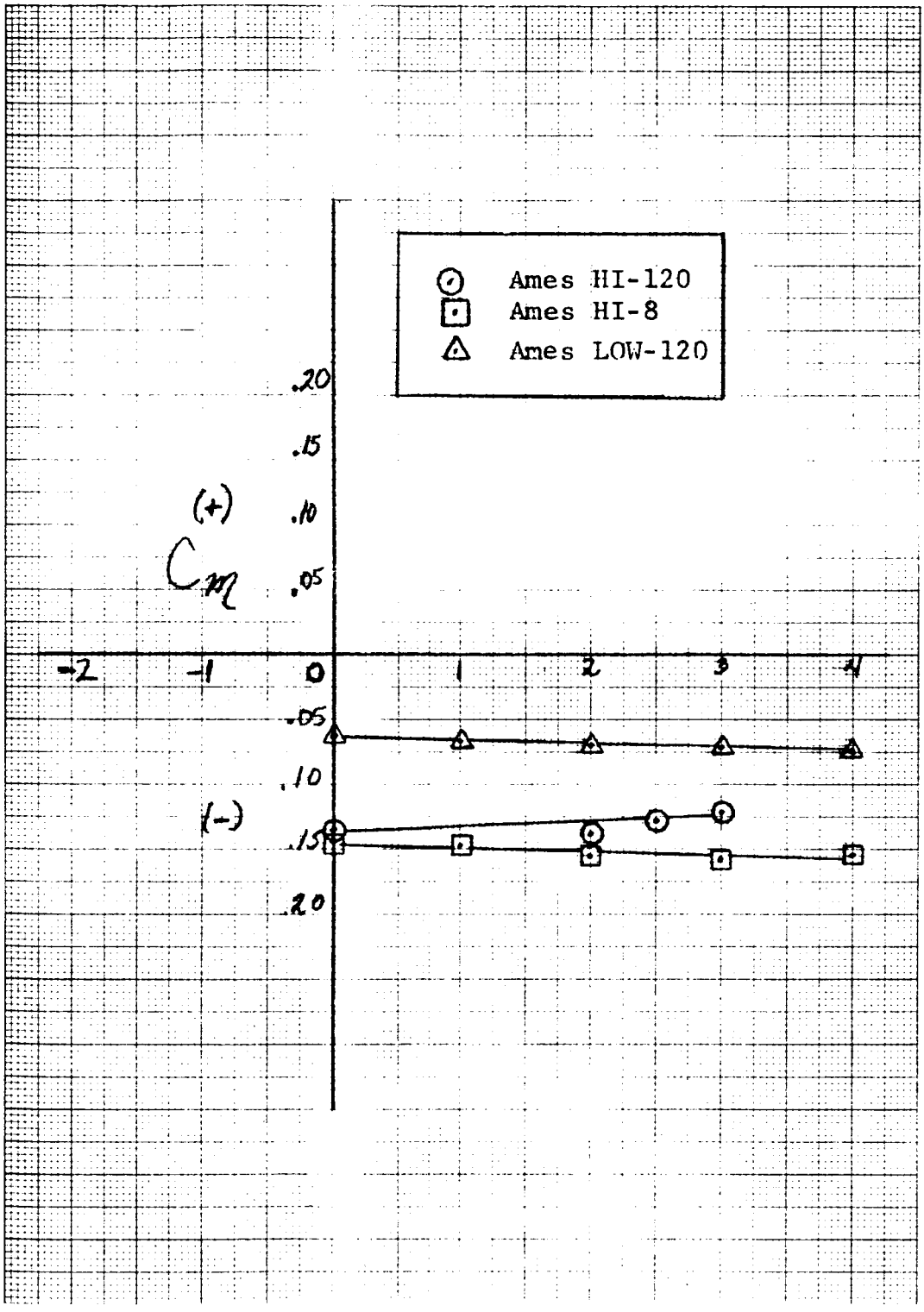

FIGURE 34 MOMENT COEFFICIENT VS. ANGLE OF ATTACK
MACH NUMBER .725

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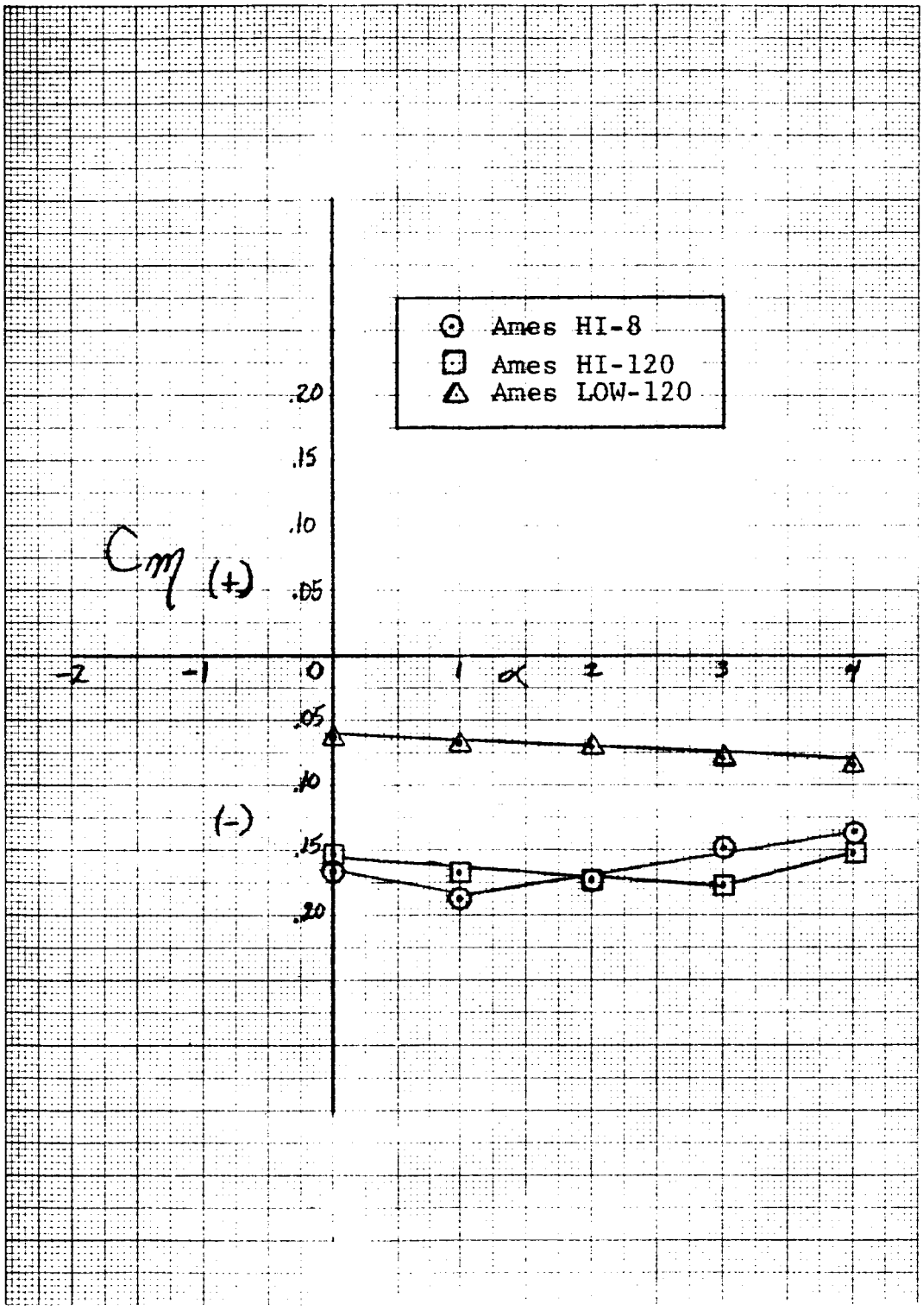

FIGURE 35 MOMENT COEFFICIENT VS. ANGLE OF ATTACK
MACH NUMBER .75

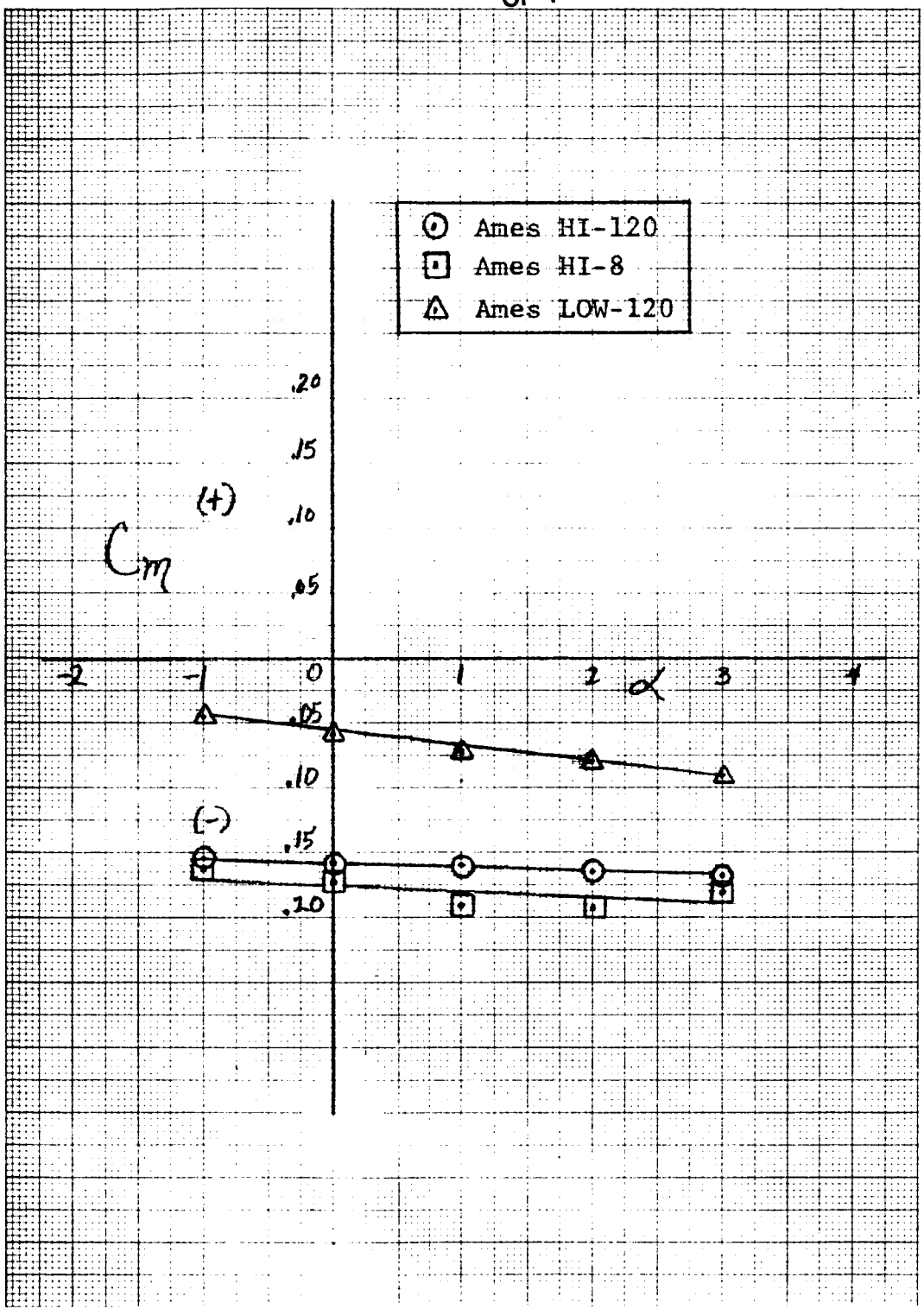

FIGURE 36 MOMENT COEFFICIENT VS. ANGLE OF ATTACK
MACH NUMBER .78

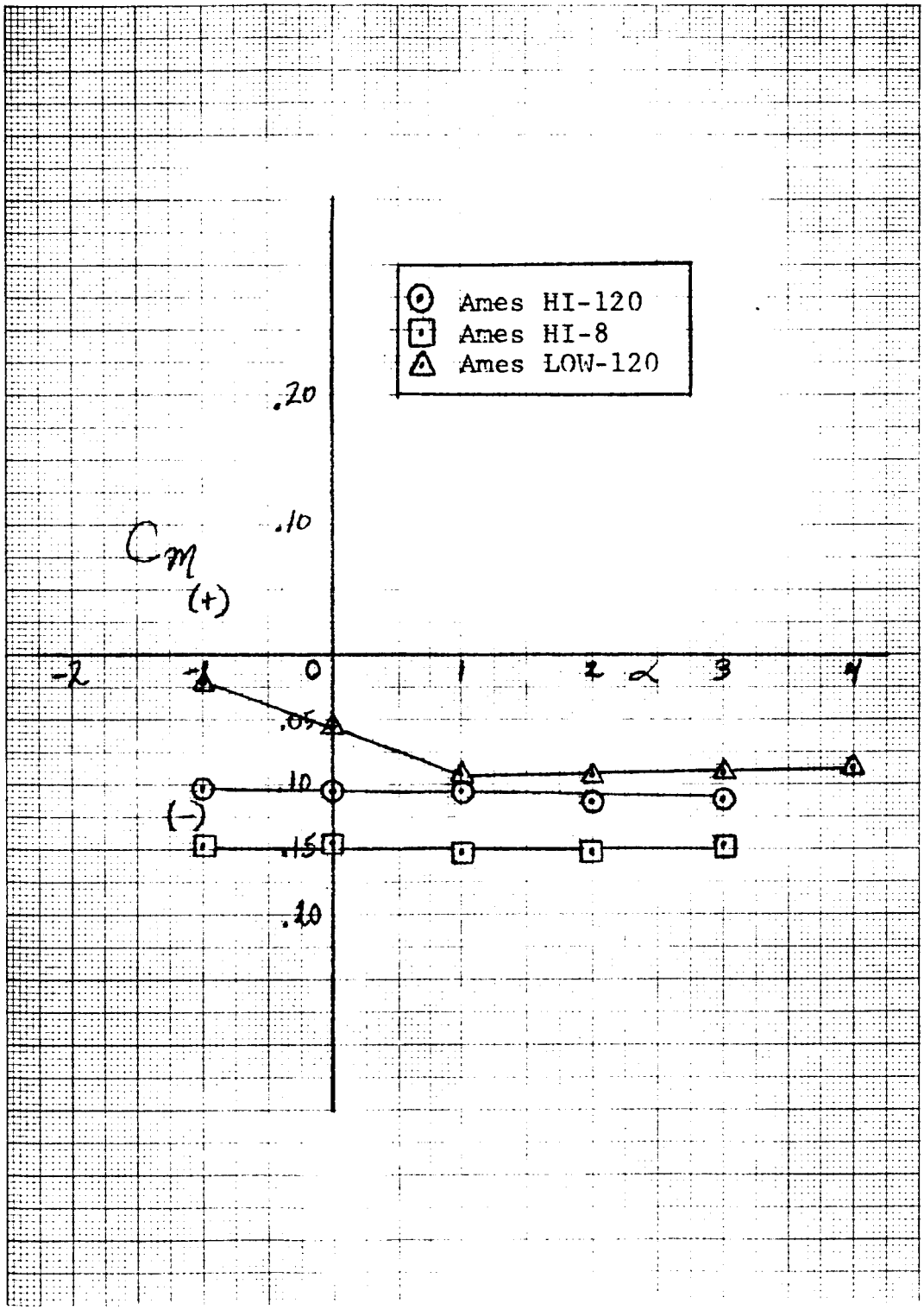

FIGURE 37 MOMENT COEFFICIENT VS. ANGLE OF ATTACK
MACH NUMBER .80

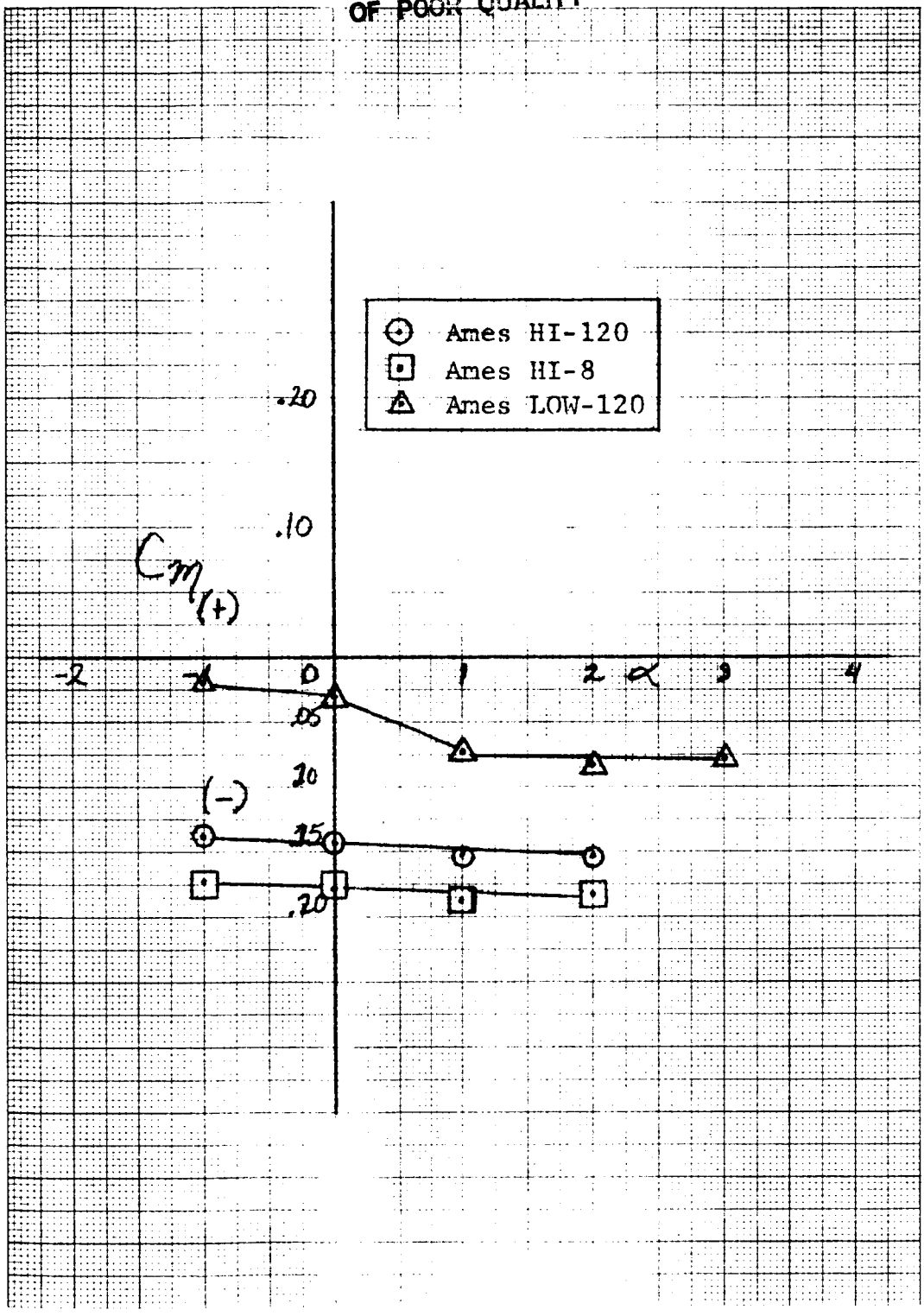

FIGURE 38 MOMENT COEFFICIENT VS. ANGLE OF ATTACK
MACH NUMBER .82

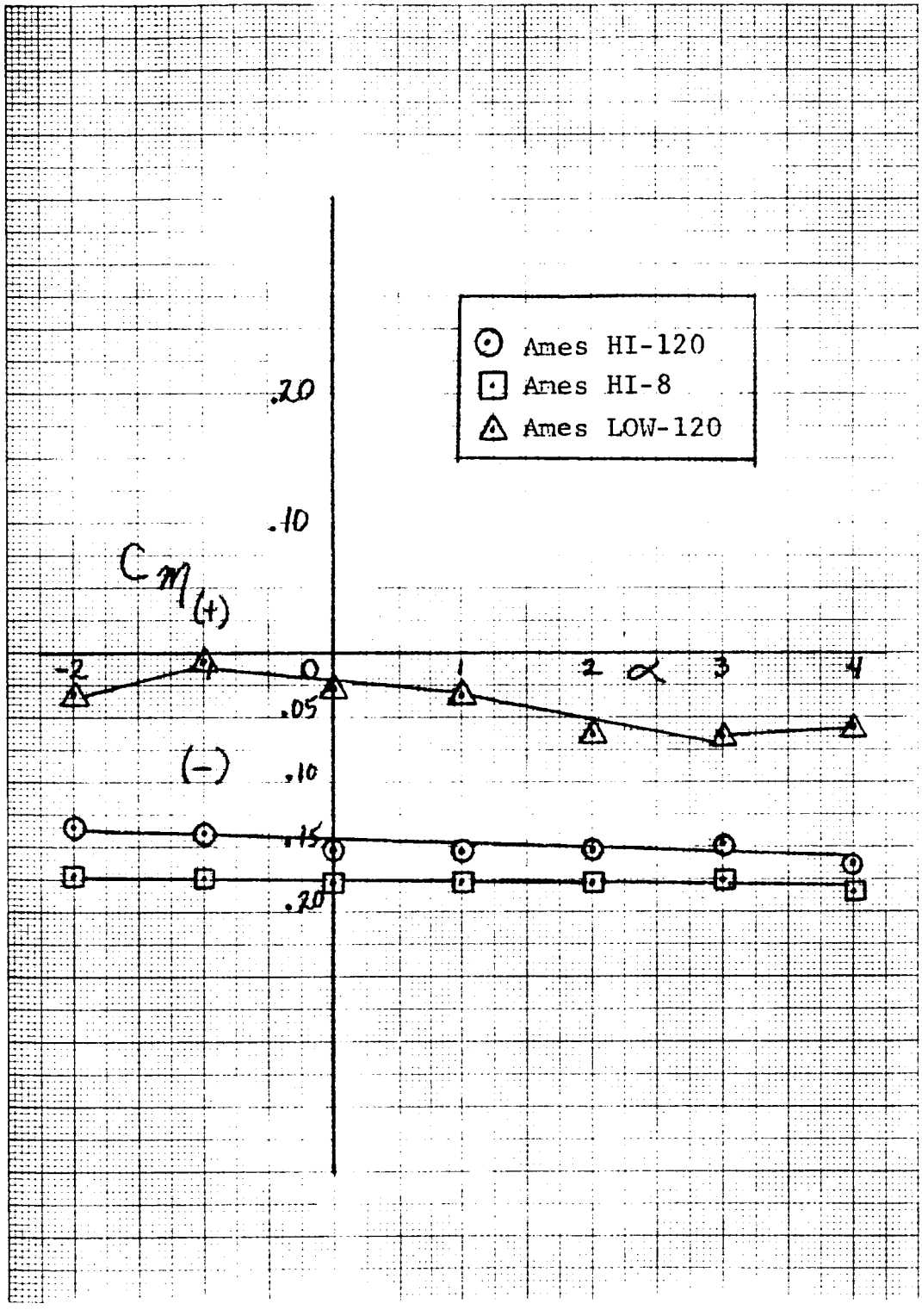

FIGURE 39 MOMENT COEFFICIENT VS. ANGLE OF ATTACK
MACH NUMBER .84

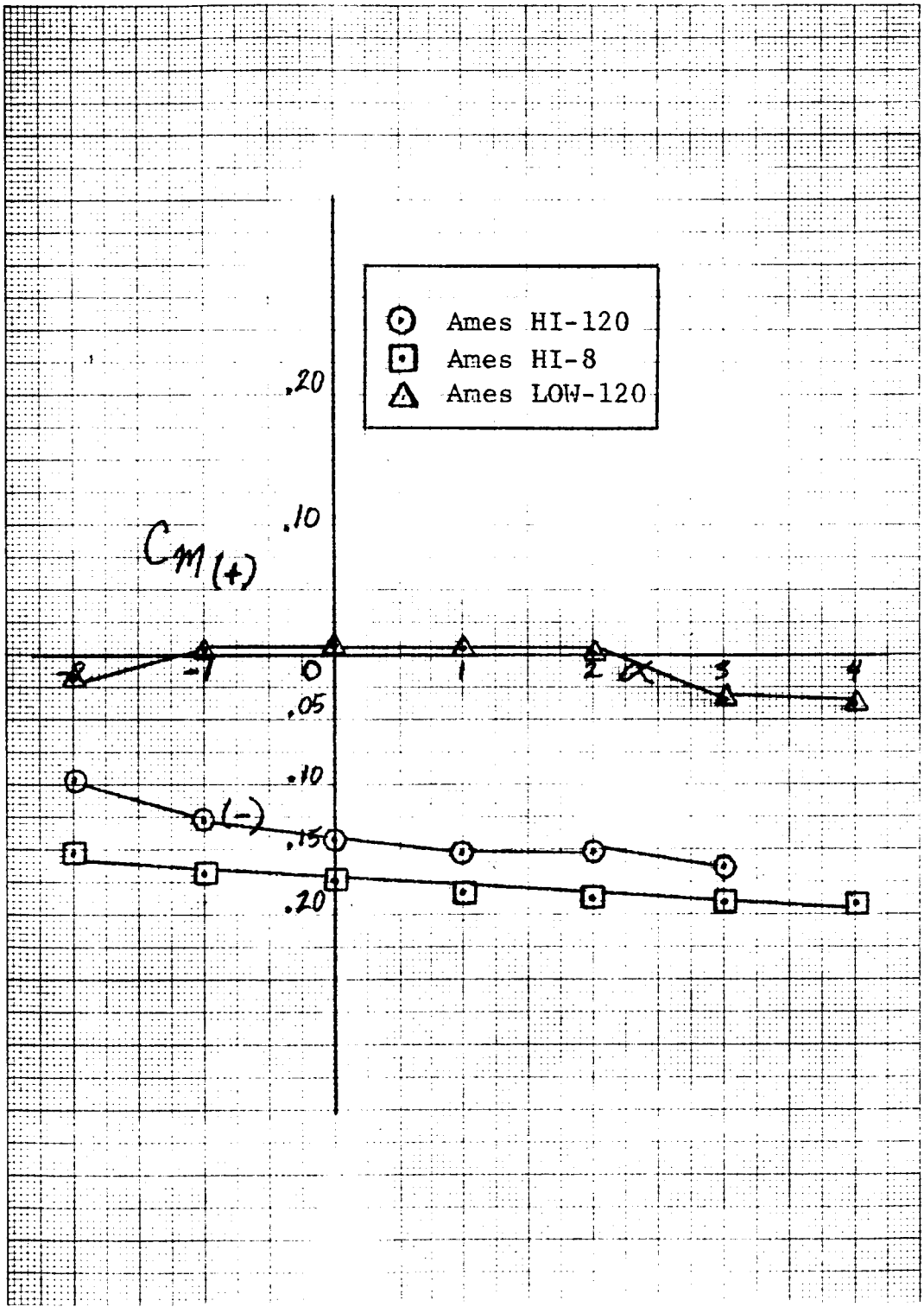

FIGURE 40 MOMENT COEFFICIENT VS. ANGLE OF ATTACK
MACH NUMBER .86